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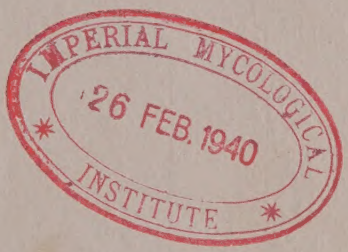

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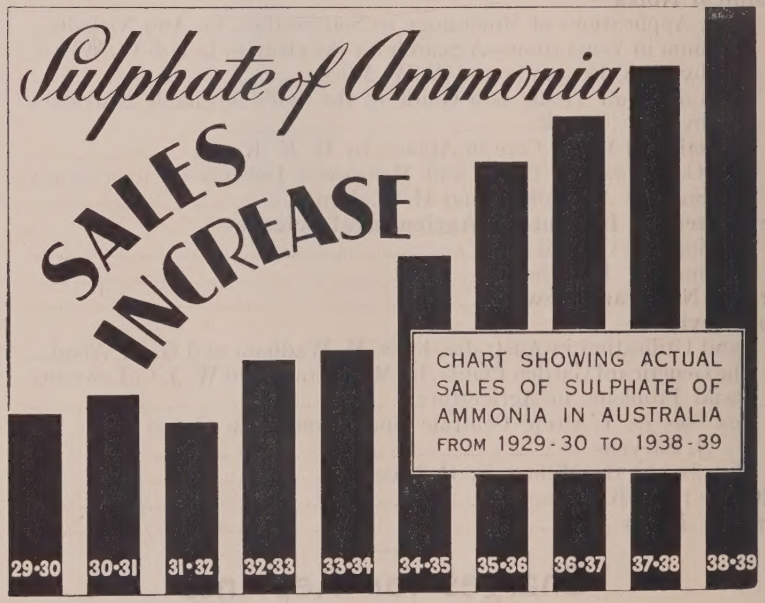

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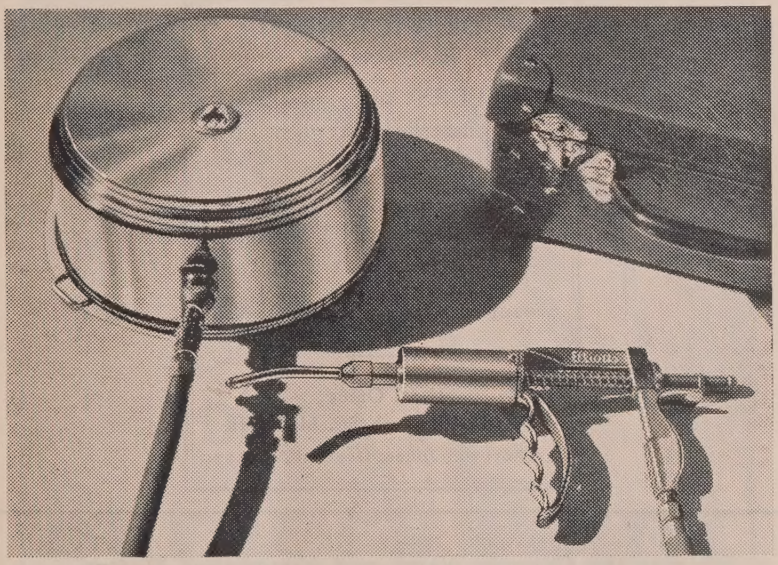

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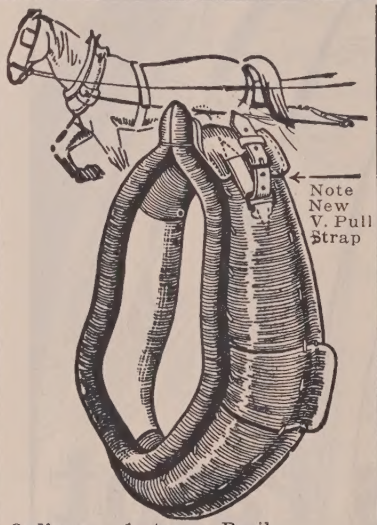

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VOL. 5, No. 4 DECEMBER, 1939

The Winter School in Soil Science

The Winter School in Soil Science held at the Waite Research Institute last August, under the auspices of the University of Adelaide and the C.S.I.R., was the first of its kind held in Australia, and the representative nature of the assembly afforded proof of the strength and activity of soil research in this continent. The School was opened by Sir David Rivett, and no fewer than 58 delegates from various parts of Australia and New Zealand were in attendance, including chemists, physicists, biochemists, botanists, plant and animal physiologists, plant pathologists, foresters and agriculturists. Soil science rests on the foundation of team work, and this ten-day conference at the Waite Institute did much to coordinate and stimulate the team spirit in this important branch of

agricultural science. The subject matter was covered by fifteen half-day sessions and a whole-day field excursion, the discussions centring upon soil classification, physical properties of the soil, soil microbiology, and soil chemistry and plant nutrition

Finality in the taxonomic classification of soils based on soil characters has yet to be reached, but the latest system—that devised by Thorp and Baldwin in U.S.A.—has much to commend it. In respect of soil physics, the parts played by the colloidal and non-colloidal fractions were discussed and an account given of the recent work on the constitution and properties of clays. X-ray data show that clays belong to three main micro-crystalline groups, and these possess definite physical properties which are reflected in the behaviour of soils with respect to moisture relations, cation exchange and cultural responses.

The moisture relations of soil are of paramount importance in agriculture, and the study of the three-phase system solid: water: air is clarifying the picture. Moisture is held in the soil by attractive forces between the water and the solid material and by surface tension in the interstitial cavities. Availability of the water to plant roots is determined by the force with which the moisture is held by the soil, that is, by the suction force of the soil. This can be arrived at by various means, such as the depression of freezing point, the tensiometer and vapour pressure determinations, and is conveniently expressed on the pF scale, which is analogous to the pH scale. This conception of moisture relationships promises to assist the agriculturist, particularly the irrigationist, in the interpretation of moisture relations for improved management of the soil with respect to water supply. The irrigationist is interested in infiltration of water into the soil as he aims to allow penetration only to the depth of the root zone of his crop for maximum economy. The use of field devices for measuring water percolation seems the most satisfactory method, but laboratory determinations (*e.g.*, heat of wetting) are of increasing value in the application of the results.

The importance of lime in agriculture has been recognized for many centuries, but the laboratory determination of an accurate lime requirement for field practice is still impossible without field experience. Laboratory methods generally involve some determination of the buffer capacity, the liberation of some constituent such as hydrogen ion or iron or the effect of neutral salts on the pH of the soil suspension, but, in spite of refinements in the analytical technique, the field test is still the basis for the determination of the value of lime for crop production. However, the pH value of soils is regarded as a very important character, and soil workers are anxious to be able to determine soil reactions rapidly and accurately.

Colorimetric and electrometric methods are available, but it is generally conceded that the glass electrode is the most satisfactory.

Organic carbon is recognised as a soil constituent of paramount importance, but most analytical methods are either very laborious or inaccurate. Dr. Walkley's indirect titration method, using potassium dichromate and ferrous sulphate, is rapid and convenient, and appears to give a reasonably accurate measure of the organic carbon content of a soil. The method commends itself to those who require sufficient information for a statistical picture of soil types in the course of soil survey and plant nutrition studies.

In this time of interest in mineral nutrition both with respect to plants and animals, it is appropriate to conclude with some mention of the spectrograph as a tool in the hands of the analyst. As an invaluable instrument for qualitative and semi-quantitative work the spectrograph is well recognised and has already made useful contributions to Australian science, but there are further possibilities. When equipped with a suitable microphotometer and using the internal standard method, quantitative work is possible, and there is no doubt that future soil chemistry and nutritional studies will receive great assistance from the spectrochemical analyst.

Increased Production from British Agriculture in Time of War

By

C. M. Donald, M.Sc.Agr.,

Pawlett Scholar, University of Sydney.

The annual value of foodstuffs imported into Great Britain is about £300,000,000 per annum. With the declaration of a state of war with Germany, there arose the possibility of restricted imports and a necessity to use to the fullest extent the limited land surface of Britain. Plans were prepared before such an emergency arose. Speaking on the Agricultural Development Bill on 3rd May, 1939, the Minister of Agriculture said that the arrangements to bring about an increase in food production in the United Kingdom in the event of war were already in the hands of the Agricultural Departments. The Government did not, however, consider it necessary to attempt this expansion to the level of production required in war-time until the actual outbreak of hostilities. The view taken was that "the best preparation for an emergency is to bring the land into a state of greater fertility, which would enable it to respond more fully to the increased demands which would be made on it in the event of an outbreak

of war". With this object of rapidly raising the general level of fertility, the payment of £2 per acre in respect of grassland ploughed prior to October 31st, 1939, was authorised. The simple conditions laid down were:

1. That the land ploughed up had been under grass for at least seven years.

2. That the land had been or was being brought into a state of cleanliness and fertility by methods such as fallowing, direct reseeding or the sowing of a suitable catch crop during the present year, such as rape, vetches, turnips, etc.

3. That the land was likely to benefit by cultivation and could, if the necessity arose, produce a satisfactory arable crop in 1940.

It was not intended that particularly poor land or cold wet soils should be broken, and in any case such soils would have difficulty in complying with the third requirement. Similarly, the breaking of the richest pastures, which might have their greatest value in their existing state, was not expected.

Arable Cropping and Temporary Ley.

In a book* written and published within a month of this announcement, Sir George Stapledon stressed the enormous potentialities of this subsidy, not only in the immediate breaking of "pot-bound" swards, but in the encouragement of a more fundamental change in British agriculture to ley farming. He advocated that millions of acres lying beneath poor or mediocre permanent pasture should be farmed by an alternation of arable cropping and "temporary" ley, the duration of the ley varying from three or four years to ten, twenty or thirty years on good and well managed grassland. In other words, he anticipated a swing to an agriculture giving a *permanent* uplift of fertility rather than a mere emergency uplift.

Sir Thomas Middleton† has also advocated the more general use of ley farming, but from the viewpoint of national defence rather than on the grounds of good farming. The short temporary ley in a rotation gives it a great flexibility and enables a rapid increase in arable area. Middleton estimated that during the period 1909-13 the mean production from 100 acres of arable land and 100 acres of permanent grassland in Britain was sufficient for the annual energy requirements of 80 and 12 persons respectively. In calculating these figures only the calorific value of foodstuffs was considered, omitting any question of essential dietary items. Although many pastures have a production far greater than the mean for the country, it is arable production that Britain requires in time of emergency.

* *The Plough-up Policy and Ley Farming.* Faber and Faber.

† Presidential Address to Section M (Agriculture), British Association Meeting, Dundee, August 31st, 1939.

With the declaration of war, the Minister of Agriculture asked for an increase of 1,500,000 acres of arable land, equal to 10 per cent. of the existing permanent grassland (as contrasted with rough and hill grazings). Adequate land suitable for cultivation is available in Britain, as shown by past and present arable acreages. In 1874 the area of arable land in England and Wales was 14,940,000 acres, while by 1936 it had fallen by 39 per cent. to 9,120,000.

At the commencement of the last war the country produced about 35 per cent. of its energy requirements, while as a result of its Food Production Campaign and consequent increase in arable acreage, it rose by 1918 to 42 per cent. Since then, four million acres have passed back to permanent pasture, and Britain starts this war with a home production of only 30 per cent. of her energy requirements—as pointed out by Sir Thomas Middleton. But this time the tractor is an enormous asset in permitting a rapid increase in arable area. Production will also be greatly assisted by the Land Fertility Scheme (June, 1937), by which any farmer is given a Government rebate of 25 per cent. and 50 per cent. on the cost (including transport) of basic slag and lime respectively.

The War Agricultural Executive Committee.

The machinery for increased food production came into immediate operation at the outbreak of war. In each county the War Agricultural Executive Committee was constituted with power:

1. To enter or inspect any land in the area.

2. To take possession, with the consent of the Minister, of any land if it appears expedient to do so.

3. To use any land in their possession in any manner considered essential for maintaining essential supplies and services.

4. To give directions for the cultivation of any agricultural land (but, in the case of land used mainly or exclusively for sport or recreation, only with the consent of the Minister).

5. To kill or control hares, rabbits, deer or any specified class of birds if these are injuring crops or wasting pasturage, or if they themselves are considered necessary for the food supply of the country.

6. To requisition stock, implements and other corporeal movables on land of which they take possession and, with the consent of the Minister, any other land.

In each county sub-committees have usually been appointed to deal respectively with cultivations, machinery, livestock, feeding stuffs, labour, etc. The task to which they are immediately applying themselves is that of increasing the arable acreage in the county. A quota has been allotted

to each county, depending on its area and its agriculture, and the county committees must endeavour to attain these quotas. The policy adopted by the committees for the time being is the encouragement of voluntary ploughing with the inducement of the £2 per acre bonus, recently extended to 31st March, 1940. As a general rule, the farmer will now be required to produce arable crops instead of having the choice, as before 3rd September, of immediate resowing to pastures. Up to mid-October, applications for the ploughing-up grant totalled 400,000 acres, compared with the official forecast made in May of 250,000 acres. This figure does not necessarily represent the increase in the arable acreage, although it must be closely related. Apart from any monetary inducement or compulsion, farmers generally are doing all in their power to assist county committees to attain or exceed their arable quota.

In cases where a motion to cultivate is served by the local committee, all tenancy agreements are over-ridden. Thus a tenant will no longer be subject to penalties for breaking up grassland in particular fields without the consent of the landlord. It is laid down that the owner of grassland broken up under an order is entitled to claim against the Government for restoration of land to its former condition after the war.

On a more modest scale, the allotment holder can help considerably to increase vegetable production. Many local schemes to make land available for this purpose have been completed.

Efforts to Increase Meat Production.

A similar effort is to be made to increase meat production. This will be done principally by increasing the sheep population, since sheep can be multiplied more rapidly than cattle; moreover, they consume less imported foodstuffs than do cattle. Quality will be sacrificed and attention concentrated on quantity. No policy is yet defined in respect of pigs and poultry, both of which are heavy consumers of cereals. Prices are to be fixed for cattle, sheep and pigs by the Ministry of Food, which will itself buy this stock when food rationing commences. The price for fat sheep has been announced as 11½d. per lb. dressed carcase weight from the time the Ministry takes full control until the end of December. No forecast is made of the prices to be paid for wheat and other crops next year, but it is the Government's intention to ensure farmers a reasonable return.

The necessity of avoiding depletion of farm labour by recruiting has been recognized. Thus in the Schedule of Reserved Occupations the age listed for farm workers is 21, except for a few relatively less skilled or less essential classes (such as drainer, strawbinder, baler, etc.), where it is fixed at 30. This means that any worker above these respective ages cannot be

accepted in any of the services, unless he is required in his trade capacity. Nevertheless, pre-war territorial recruiting and subsequent calling up of these units caused some loss, and with the increased production now required a heavy strain is placed on agricultural labour. Immediately after the declaration of war, a broadcast appeal was made for assistance with the harvest, even if only for a couple of hours. Considerable assistance is now forthcoming from the Women's Land Army. Many of these women are from large cities and have had no previous acquaintance with agriculture, but all have a great willingness to pull their weight. They spend a period of about four weeks at one of the training centres (agricultural colleges, county demonstration farms, etc.) before starting work on a farm. In some areas assistance is available from soldiers billeted in the district.

Reserves of various commodities necessary for increased production are held by the Government. Thus under the Agricultural Development Bill of May, 1939, a fund of £1,250,000 was set aside to build a reserve of tractors and other agricultural machinery. This reserve was held as stock on behalf of the Government by the dealers, in addition to their ordinary stock. It was designed to facilitate a rapid increase in arable acreage in emergency, and this machinery is now being used to correct deficiencies in various parts of the country. A dry spell in the latter half of September and early October held up the ploughing in some areas, and now all tractors, teams and ploughs are working at high pressure. Petrol restrictions do not of course apply to farm machinery.

Agricultural Research Workers.

Most workers in agricultural research institutes do not yet know how their services may be utilised. A large proportion of them are voluntarily enrolled on the Central Register of Scientific, Technical and Professional Workers compiled by the Ministry of Labour. At the end of July there were some 86,000 names on this Register, of whom 7,000 were in the section of scientific research.* The extent to which persons on this Register may be called upon for national service in their professional capacities is as yet undefined, but use has already been made of it. The Agricultural Research Council has examined the programmes and staff qualifications of the various research institutes. It is now intended to guide the work of these institutes into agricultural problems arising from war conditions. It seems probable that various phases of agricultural research will be discontinued as of insufficent immediate application and that many workers will transfer to more direct phases of increased food production. Meanwhile, the *Times* writes: "Many men—those, for instance, of military age and whose names

* *Nature*, 9th September, 1939.

appear on the Central Register—must regard the initial stage of the war as a period of waiting."

In order to enable advice on immediate technical problems of war-time production—that is, the application of existing knowledge—the Minister of Agriculture has constituted an advisory panel of agricultural scientists. The members of this panel are Professor F. L. Engeldow (cereals and crops), Professor J. A. Hanley (soils), Professor H. D. Kay (dairying), Sir John Russell (plant nutrition), Sir George Stapledon (grassland), Dr. T. Wallace (horticultural crops), Dr. S. J. Watson (green and fodder conservation), and Dr. H. E. Woodman (livestock and nutrition).

It will readily be seen that a gallant effort is being made materially to increase food production in Britain. While agriculture is not yet fully attuned to war-time conditions, there is no doubt that an immediate and probably spectacular result can be expected. One cannot forecast the precise importance of the rôle of British agriculture, depending as it does on such factors as the relative success of the enemy submarine campaign and the convoy system, but at least metaphorically—and in some degree literally—no stone will be left unturned.

Economic Problems in Agriculture

THE NEED FOR TRAINED AGRICULTURAL ECONOMISTS

By A. R. Callaghan, D.Phil., B.Sc.Agr.,

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The last decade in Australian progress, and this applies as much to South Australia as any State in the Commonwealth, has been marked by a meteoric advance in secondary industries. The causes underlying this development are many, but the most powerful forces are to be found in the world economic tension by which, and because of which, nations are raising insuperable barriers to reasonable freedom in trade, cutting the vital economic threads of inter-dependence and substituting an artificial and economically disastrous policy of self-sufficiency. This has undoubtedly been a forceful catalyst to the development of secondary industries in Australia, and achievement in this regard has been very much more rapid than even the most sanguine prophets of Australian progress anticipated. No one denies the desirability, under

existing circumstances, as well as for the future well-being of Australia, of such an advance in secondary industries. The growing recognition of the need for a balanced economy has animated government encouragement and assistance of every possible description. The enthusiasm for secondary industries is forgivable for the incentive is great and the necessity strong and urgent. Yet, in our desperate effort to meet the exigencies of the moment, the greatness of our primary industries and their needs should by no means be relegated to the background. It is in the light of this development, and one which our present vision concedes to be wise, that we should analyse the unprecedented plight of our rural producers who are faced with the depressing prospects of rapidly declining world markets associated with the gradual increase of already excessively high production costs. The difficulties the producer must face are chiefly out of his control. In fact he might well claim to be the victim of an economic swindle, if he were not satisfied that the apparent duplicity was unintentional.

Australia's Mainstay.

The development in Australia has been dependent upon agricultural and pastoral production. It is the produce of the land that has supported in the past, and will maintain in the future, the financial and industrial organisations of our large cities and other urban centres.

The flow of Australian primary produce into overseas trade has made our greatness and has in turn attracted a flow of capital to Australia. No one can deny that the real determinant to Australian progress has been the agricultural and pastoral development of Australia which has inspired confidence and given a full measure of stability to capital both for rural and industrial development. In other words, the biggest contribution to the economic life of Australia has been made by the primary producer. The non-agricultural groups in our young nation owe their existence and their well-being to the agricultural groups. Surely the significance of this fact is very often lost sight of, and it seems that our development follows an ebb and flow system rather than a co-ordinated, complete, well planned, orderly programme.

In recent years rural enterprise has been severely checked and made a less attractive investment by reason of the fall in rural commodity prices, with the result that the general trend has been for private capital to be attracted to secondary production. The farmer for his part has been forced to reckon carefully before undertaking any permanent improvements which may involve him in extra capital costs, and yet by dint of the low prices ruling in wheat and wool, such improvements must precede, or at least accompany, changes in his system of farming. At the same time, if continuation in the same line of general production is his only escape, it is imperative that his costs of production be lowered to meet the decline in produce prices, or that he be given at least

temporary accommodation over the difficult and transition period which the altered circumstances force upon him. This brings him face to face, firstly, with capital charges, and secondly, with charges inflicted by reason of the high protected prices he must pay for equipment and other secondary goods. In the latter case, he has by right a claim for some compensation ; in other words, a disability allowance in partial return for the confidence agriculture has given and the bonuses it has paid to the secondary industries per medium of the policy of protection. Capital charges, however, call for his direct and earnest consideration. Land values are far too high, and most farmers have an inordinate capacity to over-capitalise in plant and equipment to save time that economically need not be saved, and to have conveniences the costs of which are out of all proportion to their worth or economic value.

Many Problems Involved.

The problems are too involved to be unravelled in a few trite sentences, but the very evident facts of the matter are :

1. Although prices for primary commodities are low, productive costs are excessively high, and show no sign of declining.

2. The low prices obtainable are not due to overproduction so much as to a breakdown in world distribution and the policy of national interdependence. It is surely an incongruous fact that millions in China and elsewhere are starving while wheat is congesting the granaries of the world.

3. The high productive costs are the product of attempts to develop a balanced national economy, and the appalling condition of the wheat industry at present brings us face to face with the principle that primary production has a rightful claim for compensation to offset what it has paid, and is paying, by way of support to secondary industries.

4. The solvency of Australia lies in its agricultural wealth. Agricultural production goes on irrespective of whether prices are high or low, and consequently is continuously contributing to the real national wealth of Australia.

5. The problems of production and of markets, and of development, are vitally related in Australia, and the well-being of both rural and urban populations is dependent on properly co-ordinated efforts to solve the mutual problems of primary and secondary interests.

6. The farming community is at a great disadvantage in the struggle for justice that it now claims, chiefly because it lacks the organisation, direction and economic perspicacity of the industrial groups . In fact the farmer is likely to get just what others decide are needful for his retention in business, and no more.

Fundamentally there exists great weakness in the economic organisation of agriculture. In the first place there is the inherent weakness of disunity, in that the real economic unit is each farm, and unlike industrial production primary production is not under the actual control of well-informed directorates. This dispersement factor makes contact with, and control of, production such a ponderous, slow and unsatisfactory process. The dissemination of research findings to the individual units or farms is slow and tedious so that, obviously, quick and effective changes in economic policy are out of the question. Secondly, ease of production and good prices in the past have led to a policy of *laissez-faire* throughout the rural industries with the result that farming is suffering from three major ailments : (*a*) lack of economic organisation and co-ordination, (*b*) over-capitalisation due to a complete disregard of production costs due to capital, and (*c*) lack of national outlook in that farms are being farmed and stations being grazed with a total disrespect for their permanency. Depreciation ! What does depreciation mean to the average Australian farmer ?

The foregoing will serve to indicate that not only do the rural producers of Australia need systematic organisation to defend their own economic rights and economic interests but that, as individual units in the most important of all Australian industries, they should also learn to acquire a sound and workable knowledge of economic laws as they affect farm management and govern farm enterprises.

The outstanding development of the post-war period in agriculture has been the advance of scientific research work. Every avenue that time and money would permit has been exploited to increase production. Research effort has been encouraged, sponsored and generously supported by all branches of the community, and there is little doubt that enormous strides have been made as a result of these scientific efforts. Fundamental inquiry of the kind must go on, for it is the basis of progress, but the atmosphere of the true scientific research worker has been polluted by a greedy, clamorous demand from the world for spectacular and miraculous results. The time has surely come for us to take full advantage of scientific discovery with regard to rural production and make sure that the producer not only acquires a working knowledge of the new technique, but that he also acquires a sound knowledge of the economic balance of production as affected by capital costs, equipment, labour and the marketability of produce.

Need for Agricultural Economists.

Leading economists have a sound knowledge of historical agriculture. By a process of cunning interpretation of statistics and other records of the past in the light of economic laws, the reasons for many of our economic depressions, booms or other disorders are made available. However, there are very few economists in Australia—a strange but none the less true anomaly—who

have a proper understanding of agricultural and pastoral problems. We find that in economic matters governments seek the advice of professors of economics, or professors of political economy, or even professors of history. Where are our agricultural economists to advise the governments of the day on the wheat question, the wool question, the wine question or whatever the problem may be ? Who is there in Australia to tell the farmer the relative and economic advantages or disadvantages of ownership of land ? Who is there to decide the economic virtues or otherwise of combined harvesters over strippers, tractors over horses ? Who is there to point the economic lesson of employing labour to place the pig raising, poultry farming and other so-called (and economically inadvisedly called) sidelines on the basis of a proper enterprise ? Who is there to guide the farmer in the fundamental and economic problem of treating his farm as his greatest asset ? Who is there to convince the farmer with figures that he can conserve fodder cheaper by employing labour than he can buy it ? Who is there to show the farmer that depreciation costs on farm machinery may quite easily cancel out the advantages of time and convenience it offers ? Who is there to guide the farmer with facts and figures towards a permanent system of agriculture based on soil economy and the long term economic utilisation of land ? Who is there to protect with facts the vulnerable farmer from astute salesmanship, and cunningly devised selling propaganda ? Who is there to defend the rightful claims of the rural community for equitable economic treatment when artificial forces interfere with normal economic laws ? Who is there to link-up the problems of economic production in one commodity with all other branches of rural production ?

At first glance it would seem that the present organisation of agricultural research, education and extension should provide answers to all the above questions and to the many others inferred thereby. The problem is more significant than that, for apart from the scientific research field which is well provided for, the other branches of agricultural endeavour are financially stinted, and have been developed to cover essential advisory work and administration. There is urgent need for research—I use the word advisedly, but distinct from scientific research—into the field of agricultural economics. Specifically, agricultural economics from the point of view of rural production has to do with the selection of land, labour and equipment for the farm, the choice of crops to be grown, the selection of livestock enterprises to proceed with, and, vitally, the interrelationships of all these factors and how far, and in what way, they can be combined to give the most satisfactory agricultural and economic results. The economic basis for all this is in the price of land, the wages of labour, the cost of equipment, machinery and livestock and the prices for which the various products can be sold.

Australia must, out of fairness to her future development towards a truly balanced economy, pay particular and specific attention to agricultural

economics both from the national viewpoint and the viewpoint of farm management. Never before has the need for basic knowledge of the forces of agricultural economics been so glaringly patent as at the present time, a time when the whole of our social and economic order has received a brutal shock from self-sufficient nationalism, subsidised export competition and an international game of strangling reciprocity. In spite of all these upsetting factors, economic laws and facts still control to a great extent our daily lives, and business. Ultimately when sanity gains the ascendancy, programmes based on economic laws will receive the greatest reward. Australia is ready for the concerted efforts of trained agricultural economists. Money should be made available to see that the weakest link in our agricultural organisation is strengthened and that a spirited effort is made to study the agricultural economics of Australia for the Australian producer. The Australian Institute of Agricultural Science might well take the lead in this matter, and at any rate see that an initial attempt is made to answer the challenge of the present state of affairs and assist bewildered producers who have always, and will always, maintain the solvency of Australia.

Rice Culture in Australia*

By

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Rice culture has been attempted in Queensland, the Northern Territory, Western Australia, Victoria, and is now well established in New South Wales. Small areas of rice are cultivated by New Guinea and Papuan natives for their own use. No attempts have been made to grow rice commercially in South Australia or Tasmania, or, incidentally, New Zealand.

Rice in Queensland.†

Rice culture in Queensland[10, 11, 20, 21, 24] has been practically confined to the "upland" type, cultivation under flooded conditions never having been attempted on a commercial scale. Some hundreds of acres of rice were grown annually, principally in the Cairns district, during the period 1880 to 1900, but

* Paper read at the Canberra meeting of the A.N.Z.A.A.S., January, 1939.

† Based mainly upon information supplied by Mr. C. J. McKeon, Queensland Department of Agriculture and Stock.

this culture was eventually displaced by sugar cane. Rice was first introduced into cultivation in 1869. September-October sowings produced fair yields with from 20 to 30 inches of rain during the growing period, and farmers also valued the rice as green feed for stock. Individual areas were limited by a lack of suitable cultural and harvesting machinery, and production costs were relatively high. Peak production was attained in 1886 from 887 acres, which yielded 777 tons. An individual yield of 2½ tons per acre is recorded.

A revival of rice culture was attempted on the Atherton Tableland in 1917, but weeds proved troublesome and the available varieties were late in maturing ; maize growing and dairying offered greater monetary returns.

From 1919 to 1938 the area under rice did not exceed nine acres in any one year, and this was confined practically to small areas of upland rice in the northern aboriginal settlements, to augment local food supplies.

The varieties tried were chiefly Japanese, Philippine, and Javanese in origin.

Rice in the Northern Territory.*

There is no record of rice having been grown for export in the Northern Territory, but small areas were cultivated by Chinese for their own use about 1887 and later. Small areas of rice are still cultivated each year in the Aboriginal Compound ; four acres growing at present are sown with N. S. Wales seed. The flooded method of culture has been empolyed almost exclusively, and the varieties tested have been chiefly of Eastern origin.

Rice in Western Australia.†

Rice has not been grown commercially in Western Australia, but small areas are cultivated at a mission station in the north-western portion of the State to supplement other food supplies ; the upland method of culture is employed.

Rice in Victoria.‡

The production of rice in Victoria has never been on a scale which would allow it to be classed as commercial production. The first recorded attempts to grow rice were made by a Japanese farmer named Takasuka, at Nyah, on the Murray River, from 1906 until about 1927, using an intermittently irrigated upland method. Other small ventures were also made, but the crop has never

* From information supplied by Mr. H. K. C. Mair, Northern Territory Administration, Darwin.

† From information supplied by Mr. L. Jones, Department of Agriculture, Perth, W.A.

‡ From information supplied by Mr. W. J. B. McDonald, Department of Agriculture, and Mr. P. Descrimes, State Rivers and Water Supply Commission, Melbourne, Victoria.

become commercially successful. Upland varieties of Japanese origin were chiefly used.

Rice in New South Wales.

Rice culture was first attempted in New South Wales in 1891, with several upland varieties introduced by the Department of Agriculture from India. Seed of these was distributed to farmers on the Mackay, Clarence, Richmond and Tweed Rivers ; but poor yields were obtained[32] and the project lapsed until 1911, when a further collection of upland varieties was obtained from the Central Provinces, India, and crops were grown at Hawkesbury Agricultural College, Richmond, and at Grafton and Yanco Experiment Farms.[9, 13] These varieties proved too late in maturity, and the natural rainfall too small, although additional periodic irrigation was practised at Yanco.

A further trial was made at Yanco in 1916, using flooded culture, with seed of one of the best varieties grown by Takasuka in Victoria, but the results were not promising either in 1916 or 1917.

Uniform ill luck seems to have dogged these early experiments, but in any case subsequent experience has shown that all the varieties used were quite unsuited to commercial production under local conditions.

In 1922, Mr. J. Brady, then manager of the Leeton Cannery, visited California, primarily on matters connected with the canning industry, but also was commissioned by the Water Conservation and Irrigation Commission to investigate any other crops presenting possibilities on the Murrumbidgee Irrigation Areas ; he was impressed with the similarity of the soil and climatic conditions under which rice was grown in California to those of the M.I.A., and instigated the introduction of 100 lb. of seed of each of three varieties, Caloro, Colusa and Wataribune. With this seed experimental plots were established by the Commission and the Department of Agriculture, in co-operation, during the 1922-23 season. This undertaking proved to be the foundation of commercial rice production on the M.I.A.

The young industry was protected from 1926 onwards by the imposition of a Federal duty of 3/4 per cental on all imported rice, since then increased to 8/4 per cental. The W.C. & I. Commission disposed of the earliest crops for settlers until 1925-26, when a Rice Growers' Co-operative Society was formed for this and other purposes. A Rice Marketing Board was constituted in 1928, following a referendum among growers. By 1928 the M.I.A. rice crop was more than sufficient for Australian requirements, and export markets were developed. During the 1937-38 season the crop occupied an area of 24,107 acres, which yielded 42,100 tons of paddy (rough rice), exclusive of the portion kept by growers for seed. This represented an average yield of 1·75

tons per acre. The average yield has been as high as 1·95 tons per acre (1933-34), and crops yielding four tons per acre are well authenticated.[37]

Many problems arose during the early years of culture, in connection with weed control, sowing and watering methods, use of fertilizers, seed purity, and harvesting. Co-operation between growers and departmental officers in experiments soon indicated improvements in cultural methods.[12, 28, 30, 34, 35] As a matter of interest, ratooning was proved feasible, but inadvisable owing to weed infestation and reduced yields. Growers showed considerable ingenuity in adapting wheat harvesting machinery to deal with rice. Chief among these adaptations are the fitting of auxiliary motors to headers, and the use of skids under the wheels during wet harvesting conditions. Specially made pneumatic tyres have now largely obviated the use of skids, and special rice headers are now manufactured by agricultural machinery firms.

The writer was appointed by the Department of Agriculture in 1928 to commence rice seed purification and breeding work, and a Rice Research Station was established in 1929 for the investigation of fundamental problems. A continuous supply of pure seed of improved strains—Late Caloro, Caloro II, and Colusa 180—has been available for some years past [25, 28] and over 900 varieties of rice have been introduced from some 40 different countries for trial. Investigations at the Rice Research Station, on two distinct and representative soil types, have been designed to cover rice culture in its widest aspect,[17, 19, 37] including : rotation systems, involving the use of sheep ; preparation of land ; rate, time, and depth of sowing ; methods of watering ; duty of water ; depth of submergence ; weed control ; use of fertilizers ; times of draining and harvesting ; variety trials ; artificial hybridization methods[24] ; natural crossing[23] ; causes of " sun-cracking " of grain, and remedies ; factors influencing milling and cooking quality.[26]

To facilitate this work, the rice growers, through the Rice Marketing Board, have provided modern sample milling equipment, for which the Department has furnished accommodation and electric power.

Some Rice Problems.

Chief among the problems connected with rice are those of the factors, both inherent and external, influencing milling and cooking quality.[2, 4, 26] While milling quality can now be readily assessed with the aid of special small sample milling machines, a criterion for cooking quality is not so readily available. Many attempts,[1, 2, 5] both physical and chemical, have been made to develop a simple and efficient test, but to date only cooking tests under relatively standard conditions, together with the measurement of physical

characters such as water absorption, expansion, etc., are sufficiently reliable. An alkali digestion test[3, 6] appeared promising, but is not entirely consistent. Relative fat content has been suggested,[1] on the basis of preliminary experiments, as a reliable guide to quality.

Many factors influence the cooking quality of rice,[26] but the probable ultimate determinant is the nature of the starch or starches which constitute approximately 75 per cent. of the grain in the " polished " form, in which rice appears chiefly on our markets. Dextrin, which replaces starch in the group of rices termed " glutinous ", does not appear to occur at all in ordinary rices, and cannot be invoked in explanation of the widely varying behaviour of different varieties on cooking. Cooking quality appears to be conditioned by multiple genetic factors, and is apparently correlated positively with the length of the grain, and negatively with yield.

Numerous attempts to transfer the high cooking quality of certain long-grain rices to short-grained heavy-yielding types by hybridization have been generally unsuccessful. Rice breeders the world over would be grateful for a simple and efficient test for cooking quality.

Another problem, for which a partial solution has been found, is that of " sun-cracking " or " checking " of the grain. This type of damage takes the form of partial or complete fracturing of the kernels, either before or after the removal of the hulls, and is due to internal stresses set up in the grains at any time subsequent to the hard-dough stage. Relatively rapid fluctuations in atmospheric humidity[25] are responsible for these internal stresses. By far the greatest proportion of the damage occurs in the field after the crop is ripe, and before it is harvested. The chief and obvious remedies are sowing in due season, and prompt harvesting. But varietal differences occur in susceptibility to cracking, and an attempt is being made to determine the reason for this, and whether the character is independently heritable.

Still another problem is that of the length of the average flowering period, which varies with the variety and the time of sowing. In the usual commercial crop flowering extends over a period of about three weeks, owing to the commercial varieties' habit of producing a succession of panicles over a relatively long period. Consequently the ripening of a crop, or of any one plant in it, is similarly prolonged, and the earliest grain ripe is liable to suncrack before the latest is ready to harvest. There is some indication that the simultaneous heading character of some varieties is heritable, but as successive heading appears to be correlated with yielding power and is also in itself some insurance against " blasting " by occasional hot dry winds at flowering, a compromise must be sought.

Cultural Methods and Disposal of the Rice Crop in N. S. Wales.

The following is a synopsis of the cultural methods in commercial use on Murrumbidgee Irrigation Areas.[17] Shallow sowing with wheat drills takes

place mainly in early October, at the rate of about 100 lb. of seed per acre, in graded bays provided with strong banks to retain water. Sulphate of ammonia, at the rate of 2 cwt. per acre, is usually applied to land which has grown rice previously, and one or more flushings are usually given to start the crop evenly. If barnyard grass (*Echinochloa crus-galli* and *E. colonum*), the most troublesome weed, is present, the water may be held on the bays to a depth of six inches as soon as the seedlings show above ground. If a critical water temperature of 70° F. is reached within 10 days, the grass is scalded and killed while the rice, though slightly checked, rapidly recovers on draining. When the plants are from four to six inches high, water is readmitted and held until about March, when the grain is ripening. Usually about six or eight acre-feet of water are required to mature a crop, at a cost of 7/6 for the first acre-foot, and 5/- for each succeeding acre-foot of water. The cost of production is £6/10/- to £7 per acre, after the first year.

The entire crop is pooled, and is sold by the Rice Marketing Board to Sydney and Melbourne millers. The price received by growers has averaged £9 per ton of paddy.

A unique feature made possible by the centralization of rice culture on the M.I.A. is the manner in which production can be controlled in accordance with marketing prospects.

London provides the chief export market for surplus milled rice, and Australia is the only part of the Empire which produces this particular type of rice—termed " short-grain " or " Japanese ". It competes on the London market against Italian and, formerly, Spanish rice of similar type, with the advantage of a preferential tariff of two-thirds of a penny per pound.

Paddy yields from 40 to 60 per cent. by weight of polished whole rice. Broken grain is largely used in the manufacture of starch.

Rice is fortunately free from any serious diseases on the M.I.A., and stringent precautions have been taken to keep it so. Some damage by insects has been noted[16] and, despite statements to the contrary,[17] rice fields often suffer from the depredations of wild ducks and some other birds.

Extension of Rice Culture in Australia.

An agreement between the States at present confines commercial rice production to New South Wales. The estimated area which could be devoted to rice culture on the M.I.A., taking into account factors such as soil type, water supply and, particularly, three-year rotation of crops, is in the vicinity of 30,000 acres. Other N.S.W. irrigation areas in general cannot afford to apply their water supplies to rice at the expense of other profitable crops ; a similar state of affairs exists in all other States.

If demand warranted it, extensive areas of rice could be grown in Queensland, New Guinea and the Northern Territory by developing the further water

supplies which are available, but such development would necessitate major engineering projects.

Climatically, almost the whole of Australia is suited to the production of rice of one type or another. Prime essentials to commercial production are :

(1) Adequate water supply at reasonable cost.

(2) Extensive areas of flat ground with a relatively impermeable subsoil.

(3) Ready access to markets.

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Lambing and Mating Periods within the Main Sheep Areas of Australia

By

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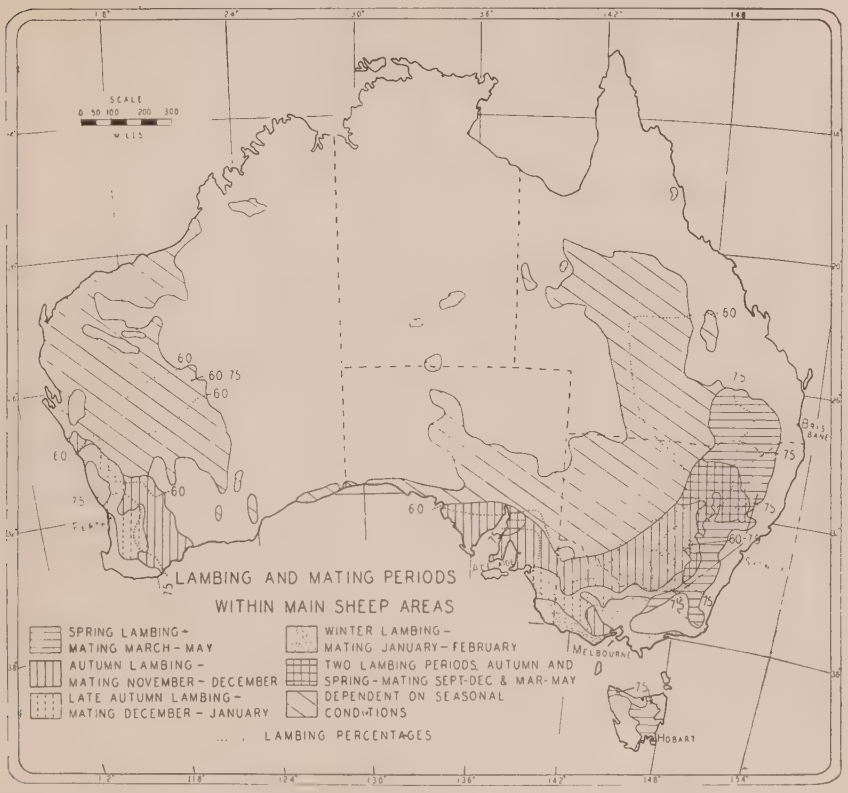
Some time ago, Dr. R. B. Kelley, of the Council for Scientific and Industrial Research, approached the Bank of New South Wales for their co-operation in securing information on sheep breeding practices, with particular reference to time of mating and lambing results in different parts of the Commonwealth. The project was undertaken, and the accompanying map was compiled from the information in 320 answers to a questionnaire sent to branches of the Bank within the sheep districts of Australia. The replies in each case were furnished by branch managers after consultation with leading sheep owners in their respective districts. In cases where there was a diversity of opinion as to what could be considered the most usual practice, the manager was in a position to weigh up the evidence and make a decision. The detailed information provided is being used by Dr. Kelley in connection with the work on fertility of ewes which is being carried out at the F. D. McMaster Field Station, St. Marys, New South Wales.

Much useful information on various aspects of sheep breeding was obtained. Of particular interest was the most usual time of mating and the lamb marking percentages in different parts of Australia. The replies to these two questions from each branch were plotted on a large scale map, and examination revealed a definite regional grouping of different periods of mating and lamb marking percentages. Six main mating and lambing periods were distinguished, and within each of these zones there was a tendency for the time of lambing to be earlier in the north than in the south.

Spring mating (November-December) with autumn lambing occurs throughout the central and southern districts of New South Wales, in Victoria, South Australia and south-western districts of Western Australia. Further south, mating takes place normally during December and January, giving a late autumn lambing. This zone is again succeeded southwards in Victoria by a region of summer (January-February) mating, giving a winter lambing. A zone of autumn mating (March-May) with a spring lambing is confined to the eastern tablelands, the Darling Downs and Tasmania, where low winter temperatures inhibit lambing before spring. Two lambing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Micro-organisms in Butter and Their Relationship to Quality

By

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The complex relationship between micro-organisms and butter quality has been the subject of considerable investigation. Although scientific literature contains results of many experimental studies on this matter, the basic principles involved have as yet been far from clearly indicated. Earlier bacteriological investigations were prompted both by the characteristic tendency of butter to deteriorate, and the widening knowledge of the part played by micro-organisms in bringing about changes in milk and other dairy products. Recent studies appear to have developed more from a sense of disappointment in the failure of previous enquiries to establish some positive relationship than from any logical sequence of experimental procedure. In making a survey of the relevant literature it would be difficult to avoid the confusion arising from the apparently conflicting results of many experiments.

It is intended in this paper rather to emphasise the essential considerations involved in any study on the deterioration of butter quality, and to indicate some of the more obvious reasons for the failure so far to establish with any degree of preciseness the biological factors concerned.

Butter Quality.

Any answer to the question of butter quality in relation to biological activity must be qualified by the interpretation placed upon the term " quality " itself. Broadly speaking, the quality of a product may be defined as the sum of those distinguishing characteristics which make it desirable and acceptable to public demand. The flavour and aroma of butter are its most outstanding features and strongly influence its quality and commercial value. While texture, colour, nutritive value and uniformity are intrinsically important, they are relatively constant characters and do not widely enter into commercial aspects of quality. As flavour and aroma are the principal factors, the problem of their estimation is necessarily deeply involved in the experimental approach to the question under consideration. In this respect, some serious difficulties are apparent. For instance, the existence of widely differing international standards or conceptions of desirable flavour complicates the interpretation of experiments carried out in other countries. Also, with the necessity for reliance upon the senses of taste and smell, flavour judgment is essentially descriptive and the absence of quantitative measurements promotes a lack of precision in experimental procedure.

Varying International Standards of Flavour.

The flavour and aroma of butter are the expression of a complex mechanism of chemical and biological reactions which are capable of being modified extensively by variations of manufacturing technique. Adaptations to climatic, economic and other conditions in various countries have tended to produce differing characteristics in butter which are often accepted as normal only by those people who have become accustomed to them. American butter, for instance, differs from the Australian product by being generally more highly flavoured, more acid and more heavily salted. Lime is widely used as a neutraliser, though its employment in this respect does not appeal to the Australian taste. In their search for a uniform butter of outstanding keeping quality, Australian producers have discarded this type of butter for a mildly flavoured, neutral to alkaline, lightly salted product. Yet the results of American experiments often indicate performances in storage of typical American butter which would not be expected in the light of Australian experience. It is apparent in these instances that the grading standards employed have not been comparable and the value of the experiments from the viewpoint of their application to Australian conditions is correspondingly diminished.

The training of the senses of taste and smell to evaluate flavour and to discern subtle differences from the normal requires long experience and acquaintance with various kinds of butter. In the final result it is subject to the personal equation and even competent judges may disagree on the merits or demerits of certain flavour characteristics. Whilst it may be comparatively easy also to compare different butters, it is always difficult to estimate changes in the one lot over different periods of time.

Other problems are involved when the experimenter relies upon market gradings for estimating the influence of micro-organisms on flavour. For instance, such gradings may in varying degrees take into consideration the necessity for keeping quality. With this idea in mind a judge may tend to grade down butters possessing a type of flavour which he, by past experience, has come to associate with inferior keeping quality, although the actual flavour itself may not be unpleasing. The intrusion of a factor of this nature may obviously frustrate the intentions of the experiment.

Influence of Physical and Chemical Constitution.

It is well known that the physical structure of butter exerts a profound influence on biological activity. Moisture in butter constitutes the dispersed phase of a fat : water emulsion and exists in the form of minute droplets, generally only a few microns in diameter. Owing to their enormous numbers, the majority of the droplets remain sterile, even in badly contaminated butter.

The chemical composition is also important. Because of its inhibiting effect, the proportion of salt and the amount of moisture present may play a

large part in controlling the activity of micro-organisms. In many experiments these proportions are not given and it would appear that little consideration has been given to the extent to which they may have exerted an influence. The curd and lactose contents are also probably significant in their relationship to bacterial activity. While the concentration of these constituents varies according to the original cream acidity and the degree of washing, there is little definite information as yet concerning their influence on bacterial behaviour. The effect of acidity on the growth of micro-organisms is well known, but the pH of the serum seems to have been overlooked in most biological studies of butter deterioration.

Difficulties of Sampling.

Of the difficulties associated with the accurate estimation of numbers of micro-organisms in butter, that of adequate sampling appears to be the most formidable. It is probable that little or none of the experimental work carried out so far would stand critical statistical analysis. Quite often, evidence from only one sample per box of butter has been relied on, and frequently the number and size of samples on which estimates of bacterial or yeast populations have been made, have not been given. A real appreciation of the extent to which bacterial and yeast counts may vary through butter and the degree to which such variations may affect conclusions is, on the whole, quite lacking. Our experiences lead us to believe that estimates of population based on an average of the number and size of samples usually taken for bacterial examinations may be wholly misleading. That this factor of variability has not been entirely overlooked is evidenced by occasional observations that counts of certain groups of organisms have shown sudden marked fluctuations during the course of storage experiments.

Conclusions from Experimental Studies.

The foregoing factors have been presented as instances of the difficulties associated with investigations on the microbiology of butter in relation to quality. Their recognition is essential for the correct interpretation of experimental results, and the following general conclusions from the data at present available must be viewed in this regard.

(1) There is at the most a very ill-defined relationship between bacterial, yeast and mould counts, and the market gradings of salted butter. The work of Demeter and Maier[2] suggests that this conclusion may not apply to unsalted butter in which, under German conditions of production, grading and marketing, a definite degree of correlation between certain bacterial counts and quality was observed.

(2) Changes in flavour under conditions of commercial cold storage (at temperatures of $-10°$ C. or lower) appear to be entirely uncorrelated with microbiological activity in all types of butter. The recent studies

of Grimes and Hennerty,[3] Arup and Gilmour,[1] and Loftus Hills, Scharp and Bellair[4] are in agreement on this point. In general, no convincing evidence of biological activity in butter under these conditions has been produced, and from theoretical considerations alone it would not be expected.

(3) At temperatures above o° C., and particularly in unsalted butter, marked degradation of quality may be brought about by bacterial development. In this respect particular organisms or groups of organisms appear to be of more significance than total bacterial populations.

(4) Bacterial, yeast and mould counts of butter reflect the degree of general contamination obtained during manufacture and may be used as reliable indices of factory hygiene.

Significance in Relation to Control of Quality.

The significance of these generalisations in relation to the problem of quality control in butter is not easy to appreciate. To some extent they even appear to be contradictory. The widespread reliance placed upon biological analyses of butter in Australia and New Zealand as a means of indicating factory contamination would be difficult to understand if such contamination was not a factor in quality determination. The lack of experimental evidence pointing to anything more than a vague relationship between grade and yeast, mould, and bacterial counts cannot, therefore, be accepted as an indication that these organisms are a negligible factor in the determination of quality.

In addition to the complicating factors previously outlined, it must be emphasised that the grade of butter is primarily dependent upon the grade of cream from which it is made. Providing that equal care is used in manufacture, there can be no reason for differences in counts between butters made from choicest, first and second grade cream. When inferior butter is made from choicest quality cream many technical aspects of manufacture, which have little or no connection with biological contamination, may be involved. Incorrect neutralising, pasteurising and churning procedures, faulty equipment and metallic contamination are important factors in the production of off-grade butter, and their effects undoubtedly obscure that of bacterial activity in general studies of quality.

None of these considerations, however, explains the fact that butter of undoubted high quality may occasionally give total bacterial and yeast counts greatly in excess of normal. These instances emphasise the importance of specific organisms or groups of organisms in butter deterioration, and suggest a wide and important scope for research. By their nature, total counts and even group counts must embrace a variety of organisms which differ greatly in their ability to affect quality. Failing the establishment of quick and accurate methods for the identification of specific destructive forms,

recourse must still be had to total counts and group counts for routine analyses, but their limitations must be appreciated.

Cold Storage and Keeping Quality.

The results of investigations into the behaviour of butter in cold storage have emphasised the predominant part played by purely chemical reactions in the impairment of quality. Also, as it has been previously indicated, it is difficult to reconcile biological activity with commercial storage temperatures, at which the moisture droplets of moderately salted butter exist in a frozen condition. Improvement of the keeping quality in storage of Australian butter has followed step by step the removal of conditions promoting chemical activity until today a high standard of performance in this regard has been achieved. The ability of butter, however, to maintain its condition under these extreme circumstances is not the sole desideratum of keeping quality. Under commercial conditions, butter is commonly subjected to temperatures which permit of bacterial development both before and after periods of cold storage. Normally at least three or four days are allowed to lapse after manufacture, during which the temperature of the butter may not fall below 5° C., and often it may be subjected to above zero temperatures for ten days or more before being consigned to storage. After storage, above zero temperatures are again encountered in order to permit of grading, printing and disposal on the retail market. The general question of keeping quality, therefore, cannot be confined to sub-zero temperatures, but must involve consideration of the behaviour of quality under conditions which do not contraindicate biological activity.

Keeping Quality at Normal Temperatures.

Evidence affirming the development of micro-organisms in butter at normal temperatures is indisputable, and on theoretical grounds the possibility of their activity cannot be questioned. Bacterial and yeast counts from unsalted butters on Sydney grading floors are generally considerably greater than those from salted butters, the disparity reflecting the inhibiting action of salt upon growth. The susceptibility of unsalted butter to bacterial attack is also generally admitted, and has been convincingly demonstrated in experiments. In both salted and unsalted butters many undesirable flavour conditions, developing sometimes within a few days after churning, are invariably associated with high counts or the presence of certain specific organisms.

Bacterial growth in salted butters at temperatures as high as 20° C. is sometimes denied by American experimenters, but there can be little doubt that their results reflect the comparatively high degree of salting in American butter. In N.S.W. butter, with salt concentrations between 1·0 per cent.

and 1·8 per cent., increases in total counts are rapid at temperatures above 5° C. Although the problem is complicated by the differential behaviour of various types of organisms, the controlling effect of salt and the influence of texture and moisture dispersion, there can be little doubt that biological factors are active in the promotion of undesirable changes at ordinary handling temperatures.

Australian Butter.

The flavour characteristics of high quality Australian butter require only a light degree of salting for their most suitable expression, and the salt concentrations usually employed are not sufficient to control bacterial growth satisfactorily. In view also of the necessity for a high standard of keeping quality under the conditions pertaining to the marketing of Australian butter abroad, the importance of bacterial contamination should not be overlooked.

From the viewpoint of what can be achieved under practical conditions of manufacture, the bacterial and yeast counts of Australian butter cannot be regarded as entirely satisfactory. The extent of depreciation represented by their activities can only be conjectured, but in the aggregate it is probably considerable. Improvements in factory design and equipment and an increasing appreciation of the importance of contamination have resulted in steady improvement in recent years, and progress is still being made.

The problem today is largely one of instruction, supervision and control, but the potentialities of research are not inconsiderable. The factors associated with many defects apparently biological in origin await clarification, and a more fundamental knowledge of the behaviour of micro-organisms in butter would greatly assist in the routine control of quality.

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William Farrer's Contribution to Our Knowledge of Inheritance*

By

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The great Australian wheat breeder, William Farrer, has rightly received world-wide recognition as an outstanding, practical plant breeder. Perhaps, however, due respect has never been paid to his contributions as a scientific investigator and as one who, through accurate technique and an enquiring, original and logical mind, enunciated and demonstrated many of the basic principles of heredity.

While several of Farrer's contemporaries, notably Hays and Saunders, were commencing by cross-breeding the improvement of physiologic characters in wheat at about the same time, Farrer must be given priority, for at least in the field of tracing the heritability of disease resistance and baking quality he undoubtedly took the lead.

Farrer appears to have evolved, quite independently, the idea of breeding for disease resistance, and when later referring to his initial breeding suggestions made in 1882, he stated that " the principles upon which the work should be carried on were then seen clearly ".

A preliminary period of varietal observation and selection led Farrer to conclude that limited improvement only could be effected by " searching for individual plants which were free from the (rust) parasite ". By 1889 he had actually commenced the combining by hybridization of the desirable qualities of rust resistance, earliness and baking quality possessed by a number of his selections from foreign and locally established wheats.

Inheritance of Rust Resistance.

While it is true that Biffen[2] first applied Mendelian ratios to a cross between a rust-resistant and a rust-susceptible variety, it was Farrer, who more than ten years previously, had first discovered, without the knowledge of Mendel's work, that the principles of inheritance were applicable to breeding for disease resistance.

The degree of success actually achieved in his programme of breeding for resistance to stem rust is, however, frequently overstated, for there is little doubt that his accomplishment in breeding for earliness, yield, bunt resistance and even baking quality met with more success than did his attempt to breed highly rust-resistant commercial wheats. The comparative lack of practical

* Paper read at the Canberra meeting of the Australian and New Zealand Association for the Advancement of Science, January, 1939.

results achieved in this field of endeavour must be attributed to the total absence of highly rust-resistant parents, a succession of dry rust-free years and lack of facilities for developing adequate rust infections. Also, for several years Farrer was side-tracked against his better judgment into breeding for resistance to leaf rust, instead of to stem rust. Moreover, the urgent demand for early drought-resistant wheats for a rapidly expanding wheat belt temporarily rendered the production of rust-resistant wheats of minor importance. He never doubted, however, that his objective would be realized, and had he lived longer he would doubtless have demonstrated more conclusively the principles he enunciated by coupling the yield of Federation or Bobs with at least the stem rust resistance of Warren or Florence—probably the highest standard possible with the parental material at his disposal.

Inheritance of Bunt Resistance.

To the problem of breeding for bunt resistance, Farrer[7] [10] [11] applied the principles of inheritance fifteen years earlier than any other worker. For, as early as 1900, in a review of his previous years' results, Farrer stated that varieties of wheat differed very considerably in the amount of resistance they offered to bunt. He then suggested, and later demonstrated, that from a cross between a resistant and a susceptible parent it was possible to fix cross-breds resembling both parental types in resistance and susceptibility, and that to isolate such types it was necessary to apply inoculum at least to the second or third generation seed. Three years later, he was able to report that while susceptible varieties were 80 to 100 per cent. infected, his new bunt-resisting hybrids showed only 5 to 10 per cent. infected plants; and he was hopeful of evolving even bunt-immune lines. The varieties Florence and Genoa are monuments to a fairly high degree of success achieved in demonstrating the heritability of bunt resistance.

Inheritance of Baking Quality.

While it is true to say that Hays,[15] Lyons,[16] Biffen[3] and Saunders[20] all followed closely on Farrer's footsteps in their efforts to improve the baking quality of wheats, none of them made crosses with this objective in view earlier than did Farrer. For at least since 1890 Farrer was engaged in this field, and he had expressed the opinion that not only could existing varieties be improved in baking quality, but that as the result of mating the highest protein wheats it would be possible to breed varieties of still higher baking quality. By 1895, Guthrie[14] and Farrer had published details of milling and baking tests on numerous parental varieties. The following year, Farrer[4] could claim the success of his programme and by 1897 the exacting quality tests to which his hybrids were subjected indicated that in such Indian-Fife hybrids as Jonathan and Comeback the quality of the Fife parent had been recovered.

In an effort to reach a still higher standard, such as was achieved in Cedar, repeated backcrosses were made to the Fife parents. Perhaps, however, the medium strong wheat Florence most nearly reached the desired goal of high baking quality combined with good yield. Farrer himself considered, however, that yield was only of secondary importance to baking quality.

Farrer[17] was conscious of the heritable nature of flour colour. The high standard he set for whiteness of flour is perhaps responsible for one of the principal features for which Australian wheats are valued on the world's markets. As with baking quality, however, he frequently appears to have expected to find the hybrid intermediate between the two parents used. That he actually found this to be so is not surprising in view of the small populations which he was forced to use, and the genetic complexity of the characters concerned.

While, therefore, it was again reserved for Biffen[1] [2] to apply the concepts of the Mendelian inheritance to grain texture and baking quality, Farrer had earlier assumed and demonstrated the heritable nature of these characters.

Independent Inheritance of Characters.

Farrer clearly realised the independent inheritance of the characters with which he was working, and he formed a rough estimate of the distribution of some of these characters within his segregating populations. These characters, it should be remembered, were largely the more obscure and complex physiologic characters of disease resistance and maturity, rather than the gross characters of plant structure studied by most of his predecessors. Notwithstanding this difficulty, Farrer so concentrated his efforts on the transference of specific characters that he was in a position to analyse his results in such a way as to entitle him to be classed as one of the immediate forerunners of the geneticist. Indeed, six years before the rediscovery of Mendel's paper, in dealing with the segregation occurring in a cross between a rust-resistant late and a rust-susceptible early wheat, he[19] clearly recorded the independent inheritance and recombination of these two characters with the recovery of the parental extremes. The proportions mentioned could actually be made to fit the expectancies for the independent inheritance of two bifactorial characters.

Farrer[12] [5] not only rightly claimed that he had followed the " practical application " of Mendel's laws for " a dozen years " prior to their publication, but he offered justifiable criticism of the original work. He had noticed, for example, cases of transgressive segregation for which at that time no Mendelian explanation had been given.

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The suggestion that Farrer made multiple crosses haphazardly merely to induce maximum variability in his segregating population is born of ignorance of the material with which he was working. Repeatedly he stressed the need for careful selection of parents and the desirability of using those possessing in the highest degree the particular characters desired in the progeny. Indeed, the complexity of his crosses is the result of his concentration on two or three specific characters carried, perhaps, in an unfixed hybrid. His use of rapid, successive back-crosses is also now recognised as being theoretically sound, especially where a special character such as disease resistance is being bred for.

Other Contributions.

Farrer[18] drew attention to the advantage to be derived from mating different geographical races and even different species of wheat, and the pedigrees of some of his wheats bear testimony to the widely different types which entered into his breeding programme. Although Farrer appears to have achieved no practical success as the result of his durum-vulgare crosses, he recorded a valuable observation which has since been confirmed and explained cytologically by Thompson,[21] namely, that in such crosses there is less sterility where the female is the vulgare parent, both in the first cross and where the F_1 hybrid is back-crossed with the vulgare parent. Ryeland, the only variety resulting from his wheat-rye crossing, was rejected by Farrer on account of its inferior flour colour and gluten quality. His supposed crosses with barley have evidently received more credence from others than he himself[5] [6] [9] gave them, for on several occasions he refused to dogmatise as to the validity of this cross.

Farrer[6] considered that relatively sparse stooling and high tiller survival were correlated with drought resistance and yield under Australian conditions—an observation since confirmed by Forster and Vasey.[13] Farrer[6] also made observations on mutations, heterosis and the occurrence of grass tufts.

That Farrer's contributions to our knowledge of inheritance have been given so little attention is perhaps due to their being eclipsed by the greatness of the economic benefits he conferred on the Australian wheat industry by the liberation of the variety Federation. While Farrer[8] knew that Federation fell far short of his standards of disease resistance and baking quality, he believed that the immediate and urgent need for a high yielding drought-resistant, strong-strawed wheat justified a compromise. Considered in this light, Federation is Farrer's supreme contribution as a practical breeder. But as the herald of a new era in breeding and as a pioneer scientist in the field of applied biology, his original contributions to theories of inheritance were demonstrated by his creation of the relatively stem-rust-resistant wheats, Warren and Florence ; the strong flour wheats, Cedar, Jonathan and Come-

back ; the leaf-rust-resistant wheat, Thew ; and the moderately bunt-resistant wheats, Florence and Genoa.

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Pollination of Fruit Trees*

THE PRESENT STATE OF RESEARCH AND ITS APPLICATION TO FRUIT CULTURE

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Information for the present national report on cross pollination is based on data supplied by the Chief Horticulturists of the Departments of Agriculture of Tasmania, Victoria, South Australia and Western Australia. The information from New South Wales was contributed by the author and the plant breeders concerned in the work.

In Tasmania, investigations on pollination are not being conducted for the reason that poor settings of fruit attributable to faulty pollination are but seldom encountered.

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In Western Australia, fruit setting and cross pollination facilities are generally satisfactory but poor setting of the apple variety Dunn's has been observed when grown only with the Granny Smith apple, although artificial pollinations carried out by Mr. W. M. Carne have indicated compatibility between the two varieties. It may be remarked here that in pollination tests this cross has given comparatively low fertility in New South Wales.

In South Australia, some pollination studies are projected in the first place with almonds, since a number of the varieties in cultivation are of local origin.

In Queensland, pollination is stated to be an important problem in the main deciduous fruit district of Stanthorpe, and work is being conducted there. Pollination with sub-tropical fruit also is in the early stages of progress.

In Victoria, pollination studies were initiated in 1933 and two reports on the work have been issued to date. Strickland[9] listed 21 varieties of apples " which showed varying degrees of self-unfruitfulness ", and ten varieties of pears which all " showed partial unfruitfulness " ; of ten varieties of sweet cherries, Napoleon alone showed a " tendency to set fruit from self-pollination (3·1 per cent. set)." A number of suitable pollinisers for several varieties were suggested. Continuing this work, Pescott and Greatorex[8] reported some detailed results with Josephine, Beurre d'Anjou and Doyenne du Comice pears, which indicated their comparative self-unfruitfulness and their compatibility with several varieties. Low fertility was shown only when Josephine was pollinated by Black Achon.

In New South Wales, specific investigations in fruit pollination and breeding were begun in 1927. The work now includes practically all fruits grown in the State, both temperate and sub-tropical kinds. Progress reports on this work are given in the annual reports of the Director of Plant Breeding.[10] With fruits, such as apples, pears, cherries, plums and almonds, whose culture is attended with pollination problems, the breeding work has been carried on concurrently with investigations on their pollination requirements. The final reports that have been issued are given in the bibliography of this report and the salient points of the work are discussed in the following paragraphs.

Pears.

With pears, extensive work has been carried out on the nature of the self-fruitfulness of several main varieties. When the results are reviewed it is found that some varieties have a distinct ability to develop fruit parthenocarpically. Thus, in classifying varieties for their dependence on cross-pollination, the relative ability to develop parthenocarpic fruit marks a first division into groups, within which a further division is made according to whether the variety is self-fertile or self-sterile.

In New South Wales, Williams, Glou Morceau and Winter Bartlett develop appreciable percentages of fruit parthenocarpically but these varieties are self-sterile, or practically so. Josephine, Winter Cole, Winter Nelis, Howell

and Beurre Bosc also have this parthenocarpic ability and, in addition, are self-fertile to a notable extent.

Other varieties are distinguished by a complete or practical absence of parthenocarpic fruit and depend, therefore, for commercial setting on seed development. Of non-parthenocarpic varieties, Beurre d'Anjou has a degree of self-fertility but a number of varieties, such as Packham's Triumph, Baronne de Mello and Beurre Superfine, are self-sterile and therefore depend entirely upon cross-pollination for fruit development.

In order of their dependence on cross-pollination for fruit setting, the results show that the least dependent is the self-fertile and parthenocarpic group, followed in order by the self-sterile parthenocarpic group, the self-fertile non-parthenocarpic and, lastly, the self-sterile non-parthenocarpic group of varieties.

Notwithstanding the ability of a variety to develop fruit parthenocarpically, results, particularly with the variety Williams, have shown distinct advantages to attend cross-pollination ; in the greater certainty of the setting of fruit, in its shape and size, chemical composition and hanging ability. Furthermore, parthenocarpic fruit development and self-fertility both vary a good deal from year to year, indicating that physiological and climatic conditions influence parthenocarpy and self-compatibility. The fruit set obtained from cross-pollination with compatible varieties also varies to some extent from year to year, but has never failed to give greater fruit setting than the natural set, and much greater setting than parthenocarpic development. Provision for cross-pollination even of more or less self-fruitful varieties is therefore the general recommendation for dessert pears.

From results with the 30 varieties of pears that have been employed in pollination tests, it appears that high cross-fertility is the general rule. Low fertility has been found only in the following cases :

(1) Packham's Triumph pollinated by P. Barry, Jargonelle and Windsor.

(2) Williams pollinated by Seckle. The reciprocal cross also shows poor fertility.

(3) Winter Bartlett pollinated by Winter Cole and Beurre Bosc.

(4) P. Barry, a triploid variety, as a fruit parent has shown characteristic generational sterility, and as a pollen parent has given lower sets on diploid varieties than diploid pollen.

Apples.

Self-fruitfulness due to parthenocarpy which is common in pears, also exists in apples, but to a much less extent. Furthermore, the principal varieties, Granny Smith, Jonathan, Delicious and Tasma, are practically self-sterile, but Rome Beauty is notably self-fertile. Because, then, of little

parthenocarpic ability and general self-sterility, at least amongst the principal varieties, much attention has been given to cross-pollination studies.

The results with some 40 varieties of apples indicate that cross-fertility is the general rule, as is the case with pears. Low fertility has been found only in the following cases:

(1) Granny Smith pollinated by Statesman and Dunn's, as well as the reciprocal pollinations.
(2) Pollinations between strains or bud sports and the parent variety, such as between Delicious and Lalla or between Rome Beauty and the several strains of Rome Beauty.
(3) Granny Smith, Jonathan, and several other varieties when pollinated by Stayman.
(4) Gravenstein has shown the characteristic generational sterility of triploid varieties.

Cherries.

In agreement with the generally reported self-sterility of sweet cherries, pollination studies in New South Wales have shown complete self-unfruitfulness in the principal sweet cherry varieties in this State, viz. St. Margaret, Noble, Florence, Napoleon, Early Lyons, as well as in Early Rivers.[1]

Each of these varieties, except Florence, has also been found to be unfruitful with a group of other varieties. The incompatible groups to which belong Early Rivers and Napoleon, as reported by other investigators,[3 4] were confirmed and two new incompatible groups were found, as follows:

(*a*) St. Margaret, Noble, Black Republican, Black Bigarreau.
(*b*) Early Lyons, Twyford, Bigarreau de Mezel.

The reciprocal crosses, where tried, have also been incompatible.

Because of the self-unfruitfulness and the incompatibility between certain varieties, sweet cherries are entirely dependent upon suitable cross-pollination for productivity. Suitable pollinisers may be chosen according to their blossoming period, their economic qualities, and their compatibility status.

Fortunately, many compatible relatives of a variety may be determined from a comparatively few crosses by employing the systematised knowledge of cherry pollination developed largely by Crane.[4] For this purpose, however, correct nomenclature, although difficult and desirable for economic reasons, assumes first importance.

European Plums.

Pollination studies with European plums have been conducted by the author co-operatively with the plant breeders at Bathurst Experiment Farm. The pollination of prunes has been studied at Yanco Research Station by Mr. W. Poggendorff. The results might be considered together, the two kinds of plums being of the one species. The varieties studied group themselves as follows:

Self-sterile (less than 1 per cent. set) : Grand Duke, Robe de Sargent, Prune d'Agen, Imperial.

Slightly Self-fertile (but insufficient for commercial cropping) : President, Ponds, Blue Imperatrice, Angelina.

Self-fruitful (for commercial cropping) : Giant.

Cross-pollinations between the dessert varieties alone and between the prune varieties alone have shown that the varieties of each kind are cross-fertile. Some crosses between dessert plums and prunes also show them to be cross-fertile. Cross pollination of European plum varieties in New South Wales has not disclosed any incompatibilities or the type of unreciprocally compatible combinations that Crane has reported in the varieties he studied.[3]

Japanese Plums.

Pollination studies with Japanese plums have been conducted by Mr. N. S. Shirlow at the Hawkesbury Agricultural College since 1929. The results of self-pollination studies permit a sharp division into those varieties, which are self-fertile to the extent of commercial cropping, such as Santa Rosa and Satsuma and other varieties which are self-sterile, e.g. Chalco, Shipper, Shiro, Narrabeen, Cyco Smomo and Sultan.

The results of cross pollinations made between these varieties show that they are all compatible with one another. No incompatible combinations have been found in the Japanese plum.

A number of Cerasifera plums have also shown complete cross-compatibility with Willson's Early Plum, which is presumed to be a hybrid between *P. cerasifera* × *P. salicina*.

Almonds.

Almond pollination is being studied by Messrs. Poggendorff and Bryden at Wagga Experiment Farm. Of the thirteen varieties under test, some are completely self-sterile, others are slightly self-fertile, but none are self-fertile to the extent of commercial cropping.

Cross-pollination tests show that the majority of varieties are cross fertile with one another. The indications at present are that no combination is incompatible, although low cross fertility has been established for Brandis Jordan pollinated by Jose's Jordan, Jordan Hardshell and Large Papershell. Suitable pollinisers are recommended according to the blossoming season, economic qualities and the compatibility between varieties. Particular attention has been given to the determination of the period of bloom and varietal identity in almonds in New South Wales.

Summary.

Apart from the investigations reported from New South Wales and Victoria, little pollination research work has been carried out in Australia.

Studies in Victoria have shown the generally low degree of self-fruitfulness of apple and pear varieties and the self-sterility of cherry varieties. A number of cross compatible relationships of some varieties were reported from which suitable pollinisers were suggested.

In New South Wales, extensive pollination investigations are in progress concurrent with a fruit breeding programme. Annual progress reports from 1927 to 1937 and some final reports have been published, following the objective of ascertaining the pollination requirements of the main varieties of deciduous fruits. The degree and nature of self-fruitfulness of many apple and pear varieties have been established in relation to their dependence on cross-pollination for fruit setting. The secondary effects of seed development derived from cross-pollination upon shape and size, chemical composition and hanging abilities of the fruit, as shown by the studies with Williams pear, have led to the recommendation, even for self-fruitful varieties, of cross-pollination. Cross-pollination studies have established a long list of compatible crosses, from which the most suitable varieties may be recommended. Several unfruitful crosses have been established.

Studies with sweet cherries established their entire dependence on cross-pollination for fruit setting. Suitable varieties for this purpose were recommended after consideration of their compatibility, their blossoming period and their economic qualities. Certainty of varietal identity is of great importance.

Investigations with European, Japanese and cherry plum varieties have shown the individual self-fruitfulness of the principal varieties, and satisfactory pollinisers have been indicated for most varieties.

With almonds, no variety has been found sufficiently self-fruitful for commercial cropping without cross-pollination, though some varieties show a degree of self-fruitfulness. Suitable pollinisers for the recommended commercial sorts have been established on similar considerations to those which apply to the cherry, except that absolute cross-incompatibility does not seem to occur in the almond.

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TECHNICAL NOTES

SOME APPLICATIONS OF MINERALOGY TO SOIL STUDIES.

Soil mineralogy may be of value to the agriculturalist in indicating: (1) the probable source of the soil-forming material, (2) the state of maturity of the soil, and (3) the fertility of the soil. This note summarises the results of the study of a large number of Victorian soils. Work has been confined to the fine sand fraction (0·2 to 0·02 mm. diameter) since this may be readily examined by ordinary microscopic methods. The coarser fractions usually consist almost entirely of quartz, and the still finer fractions contain increasing amounts of secondary minerals.

Probable Source of the Soil-forming Material.

(*a*) *Relation between Soil and Underlying Rock.*

Many soils contain high proportions of minerals which could not have been derived from the underlying rock. The outstanding example of this is the occurrence of quartz in soils derived from basalt. Mechanical analysis of a typical podsolic soil developed on the Pliocene basalt of the Victorian Western District shows 49 per cent. of fine sand in the A horizon (0-8 inches) and 20 per cent. in the lower B horizon (27-60 inches); this fine sand contains 88 per cent. by volume of quartz, with traces also of zircon and tourmaline, and only 4 per cent. of basaltic minerals, such as plagioclase and ilmenite. This mineral composition is indistinguishable from that of the fine sand of podsolic soils developed on Quaternary deposits in the same district. "Red loams" on the still older Oligocene basalts of Gippsland show only a trace of plagioclase in the fine sand, which forms 20 per cent. of the B horizon, and is 92 per cent. quartz. Mineral analysis of these soils without field study would therefore have suggested an entirely different parent material.

Soils on basalt are, of course, an extreme case since the basaltic minerals are readily decomposed, but the presence of some "foreign" material in the soil appears to be universal. For instance, in a series of soils taken from Berwick, an attempt was made to trace the extent to which the granite from the hills had contributed to the soils of the plains; the fine sands were examined for hornblende, which occurs in the granite but not in the other rocks of the area. Some hornblende was, however, found in soil developed on Silurian sedimentary rocks at the top of a small hill. Further evidence of general contamination is provided by the occurrence of fresh-water sponge spicules in all the Victorian soils examined; similar spicules have been identified in samples provided by the Waite Institute from such unlikely places as Gibson's Desert and The Granites, Central Australia.

One may conclude that this contamination is due to the addition of wind-blown material to the surface of the soil, and its gradual penetration down cracks

to lower levels.[1] The amount of foreign material naturally forms a higher proportion of the fine sand when the underlying rock consists of minerals which are so unstable that they do not remain in the sand fraction ; but some degree of contamination appears to be so general that it must set severe limits to the possibility of determining the underlying rock by qualitative examination of the soil minerals. In particular, the use of a " key " mineral as indicative of a certain underlying rock appears highly dangerous unless the mineral is absent from all other soils in the area, and correlations must usually depend on quantitative work with all its statistical limitations. Valuable qualitative results may be obtained in certain areas, particularly where the rocks consist of resistant minerals, as in the work of Carroll in the goldfields area of Western Australia.[2] but such methods do not appear to be universally applicable ; indeed the notion that fine-sand minerals are necessarily derived from the underlying material has an unfortunate resemblance to the conception of soil merely as decomposed rock.

(*b*) *Origin of Transported Material.*

Certain specific minerals may be useful in determining the origin of the material which has been transported. Numerous studies in Great Britain of young soils derived from glacial drifts provide an excellent example of this. The same line of attack was useful in a soil survey of the Kerang district,[3] where difference of parent material between the " Pyramid Creek " suite and the " clay " types was established by the presence of hornblende in all soils of the first group and its absence from the second. With favourable conditions, such as the presence of some unusual mineral in the sand fraction, mineralogy may supply information which cannot well be obtained from other sources.

Maturity of the Soil.

The mineral composition of the fine sand may also give interesting evidence as to the state of maturity of the soil. In particular, a high concentration of unstable minerals has frequently been found in soils developed on hillsides, indicating the effect of natural erosion in removing weathered surface material. For example, the basalt " Stony Rises " of the Western District have on their slopes a brown loam which gives place to a black calcareous clay at the foot of the slope, while the mature soil developed on the surrounding basaltic plains is a grey loam. The accompanying table shows the higher concentration of unstable basaltic minerals on the slopes.[4]

Fertility of the Soil.

There is a general correlation between immaturity and fertility in the areas of higher rainfall, but fertility is far too complex to be related to

Average Percentage Volume of Minerals in the Fine Sand.

	Brown Loam.	Black Clay.	Mature Soil.
Rock fragments	**7·6**	**0·3**	Trace
Augite	**12·3**	**1·0**	Trace
Plagioclase	**19·3**	**8·7**	3·9
Olivine	**2·2**	0·8	0·5
Iron oxide	**8·4**	1·7	1·2
Quartz	50·3	86·8	93·7

Figures printed in black are significantly higher than those for mature soil.

immaturity alone and may, in fact, have no connection with parent material. While, therefore, the primary soil minerals may give useful evidence regarding the fertility of the soil, such evidence can be regarded only as supplementary to field work and general soil analysis. For example, on the Silurian mudstone of the Kinglake plateau, comparatively fertile " red loams "—similar to the basaltic red loams of Gippsland—occur, as well as the normal poor podsolic grey loams. These red soils are used for potato growing, and the farmers of the area refer to them as " volcanic ". There is, however, no evidence to support this term, and the soil minerals of the red loams and the grey loams are indistinguishable. In such cases, therefore, mineralogy gives no evidence as to the relative fertility of the soil.

Improvements of Technique.

Qualitative work is made much easier by the concentration of certain minerals, according to their specific gravity, by means of such heavy liquids as bromoform, nitrobenzene and tetrabromöethane mixture, or Thoulet's solution (potassium mercuri-iodide in water). Quantitative work would also be greatly improved by these methods if it were possible to make separations complete ; this applies particularly to minerals present in small amounts, and these often provide very useful information. Recent workers[5, 6, 7] have used a centrifuge to assist separation, and claim quantitative results. It may be noted that even when the various difficulties in technique are overcome—such as the complete removal of the light (floating) fraction from the centrifuge tube—there still remain certain minerals, e.g. quartz and plagioclase, with specific gravities so similar that they cannot be separated by this method. There seems, therefore,

to be no way of avoiding the necessity of identifying and estimating the percentages of such minerals by optical methods, but in spite of these drawbacks it is clear that in many cases specific-gravity methods may be of great value.

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SELENIUM IN VEGETATION—A SEARCH FOR THE ELEMENT IN N.S.W. WHEAT.

In 1934, Henry G. Knight[1] in an address to the Association of Official Agricultural Chemists, directed attention to the element selenium which had been found to occur as a constituent of vegetation in certain localised areas of the United States.

Byers *et al.*[2] studied the distribution of selenium in a number of States and reported the occurrence of seleniferous areas in parts of Kansas, New Mexico, Arizona, Utah and Colorado. Knight and Beath[3] showed its presence in the rocks, soils and vegetation of parts of Wyoming. Moxon,[4] in a lengthy memoir, discussed the distribution of the element in South Dakota, and the relationship of selenium poisoning to " blind staggers " and " alkali disease " prevalent amongst livestock in the Great Plains region.

Byers and his co-workers[5] found selenium in lavas and some of the soils of Hawaii, and from their observations inferred that it was derived from volcanic gases or sublimates. The selenium present in the sedimentary formations of the United States is considered by them to be also primarily of volcanic origin. They explain its accumulation in semi-arid soils, and point to the probability of its occurrence in low rainfall areas in other parts of the world.

Since its discovery in 1817 by Berzelius and Gahn, selenium has been employed in industry in many ways ; it has been used in glass, pottery and rubber manufacture to some extent ; its electrical behaviour when exposed to

light has led to the development of the photo-electric cell and to light-controlled automatic equipment of various kinds; colloidal selenium has fungicidal properties, and an organic selenide serves as an " anti knock " agent when added to petrol.

The element belongs to the same chemical group as sulphur, and resembles the latter in many of its properties and its capacity to exist in allotropic forms. Its physiological effect on the animal body when ingested is stated by Mellor[6] to be similar to that produced by arsenic or antimony: it weakens the heart's action, lowers the blood pressure and paralyses the nervous system.

Selenium is capable of being absorbed by grain crops, grasses, and other vegetation from soils containing it in available form, and of rendering such material toxic to a greater or less extent.

Absorption of Selenium by Plants,

In connection with the absorption of selenium by plants, the following are extremely interesting and important features: It may accumulate in plants until its concentration in the latter is several hundred times greater than it is in the soil. Considerable amounts of the element may be absorbed by plants without the latter being perceptibly injured, despite the fact that such vegetation—if fed to livestock—is definitely toxic. Plants vary enormously in their capacity to take up the element from soils of the same selenium content. Thus Hurd-Karrer,[7] amongst much other experimental data of a similar nature, records the selenium content of a number of annual plants grown in green-house soils to which selenium had been added at the rate of 5 p.p.m. of soil. The selenium found in these different plants varied in amount from 130 p.p.m. to 1240 p.p.m.

Knight[8] refers to analysis of vegetation growing on a plot of soil containing 2 p.p.m. selenium. Native grasses growing on this soil contained 9 p.p.m. selenium, while a species of vetch (*Astragalus bisulcatus*) contained as much as 1250 p.p.m. Wheat growing in an adjacent plot contained 45 p.p.m., while *A. bisulcatus* growing amongst this wheat contained 1110 p.p.m.

Byers *et al.*[9] found narrow-leaf milk vetch (*A. pectinatus*) with a selenium content of 2070 p.p.m. growing in a soil which contained only 1 p.p.m. of the toxic element.

The fact that certain plants have the power to absorb selectively and accumulate in their tissues relatively large amounts of selenium although they may be growing on soils of low selenium content is a matter of considerable practical importance, since as the result of death and subsequent decomposition of such plants the available selenium in a soil may be locally increased.

Weeds and other plants having a high capacity for selenium absorption have been called " converter " plants, and their presence on land may play an indirect part in increasing the toxicity of other vegetation which at first was only moderately seleniferous.

Among plants stated to be important in this respect in Wyoming are the following: *Astragalus bisulcatus, A. pectinatus, Atriplex nuttallii, A. canescens* and *Oonopsis condensata.*

In 1936, Robinson[10] reported the presence of selenium in a number of samples of foreign-grown wheat, and suggested that wheat might be used as a possible "indicator" of the distribution of selenium in soils.

Survey in New South Wales,

The fact that samples of New South Wales wheat were among those which were stated to contain traces of selenium led us to think that a reconnaissance survey for this element in wheats from different districts of the State, and also possibly for its distribution in native vegetation of the lower rainfall areas, might be worth while. With this end in view, samples of wheat were obtained from the chief wheat-producing districts of the State. These samples, 20 in all, consisted of 17 from various country silos, representative of much of the commercial wheat of N.S.W., and three other samples from Gunnedah, Temora and Wagga respectively. These samples were examined for their selenium content, by the method of Robinson *et al.*[11] as modified by Williams and Lakin.[12] In this method, selenium in the prepared samples is volatilised in an all-glass distillation apparatus as selenium bromide, and the distillate is subsequently treated with sulphur dioxide and hydroxylamine hydrochloride, for the separation of the element.

In the examination carried out, it was found that no more than a trace amount of selenium was present in any one of the 20 samples collected. Since these samples may be regarded as fairly representative of a large proportion of New South Wales commercial wheat, the results of this preliminary finding in regard to their selenium content appear reassuring.

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TESTS ON PLANT TISSUE AS A GUIDE TO THE SOIL'S AVAILABLE NUTRIENTS.

Thornton, Conner and Fraser[1] have presented methods for examining, by rapid chemical tests on living tissue, a plant's requirements for nitrogen, phosphorus, and potash. These elements are absorbed from the soil as simple inorganic compounds. When there is an abundant supply of an element in the soil, the inorganic salts of that element tend to accumulate in the vascular tissue of plants where they can be detected by chemical methods.

The nitrate test on material from the base of the main stem has already been described in this Journal.[2] The phosphate test on material from near the tip of the main stem is described in Appendix I.

A rotational and manurial experiment provided material for testing the reliability of the above methods, as it involved the application of super-

TABLE 1.—*Nitrogen as nitrate in plant tissue—sampled during bright weather. The figures are the numbers of samples in each group of total amounts of nitrogen (in microgrammes). All samples were similar in size and contained either 2·4 mg. of dry matter (cereals) or 4·4 mg. of dry matter (peas).*

	Nil.	Trace.	Microgrammes.			
			<0·1	0·1–1	1–10	>10
Barley on stubble						
N_0				8	1	
N_1					9	
N_2					1	8
Oats on stubble						
N_0	8	1				
N_1	2	4	3			
N_2		2	7			
Peas on stubble						
N_0			3	6		
N_1			1	6	2	
N_2				5	4	
Wheat on stubble						
N_0			7	2		
N_1			3	3	3	
N_2			1	1	7	
Wheat on fallow						
N_0					2	7
N_1					1	8
N_2						9

N_0=No nitrogenous fertiliser.
N_1=Sulphate of ammonia, 1 cwt. per acre.
N_2=Sulphate of ammonia, 2 cwt. per acre.
1 microgramme=0·001 mg. of nitrate N in sample.

phosphate, sulphate of ammonia, and lime, on fallow-sown wheat and stubble-sown barley, oats, peas, and wheat. Each of the fertilisers had been applied at three rates, alone and in all possible combinations.

The colours produced in the nitrate and phosphate tests were compared with a range of standards having known amounts of nitrate nitrogen and phosphate phosphorus, respectively. The results of a series of tests in August, 1938, are summarised in the accompanying tables.

Table I shows the ranges of nitrate concentration in the nine plots at each of the three levels of sulphate of ammonia.

Table II shows the ranges of phosphate concentration in the nine plots at each of the three levels of superphosphate.

In all the crops studied, the nitrate nitrogen tended to be highest in plants from the plots that had received the heaviest dressing of the nitrogenous

TABLE 2.—*Phosphorus as phosphate in plant tissue—sampled during bright weather. The figures are the numbers of samples in each range of total amounts of phosphate (in microgrammes) in the sample which contained either* 0·3 *gr. of dry matter (cereals) or* 0·5 *gr. of dry matter (peas).*

	Trace.	Microgrammes.			
		<0·1	0·1–1	1–10	10–100
Barley on stubble—					
P_0	9				
P_1	8	1			
P_2	4	2	3		
Oats on stubble—					
P_0		7	2		
P_1		1	5	3	
P_2			3	6	
Peas on stubble—					
P_0				8	1
P_1				5	4
P_2				1	8
Wheat on stubble—					
P_0			6	3	
P_1			1	8	
P_2				8	1
Wheat on fallow—					
P_0		5	4		
P_1			1	8	
P_2				9	

P_0=No phosphatic fertiliser.
P_1=Superphosphate, 1 cwt. per acre.
P_2=Superphosphate, 2 cwt. per acre.
1 microgramme=0·001 mg. of phosphate P in sample.

TABLE 3.—*Nitrogen as nitrate in plant tissue—the effect of sampling during bright sunshine and in dull weather.*

Crop.	Manurial Treatment.	Weather.	Microgrammes.			
			<0·1	0·1–1	1–10	>10
Peas on stubble.	N_0	Dull		3	6	
	N_0	Bright	3	6		
	N_1	Dull		1	8	
	N_1	Bright	1	6	2	
	N_2	Dull			9	
	N_2	Bright		5	4	
Wheat on stubble.	N_0	Dull			9	
	N_0	Bright	7	2		
	N_1	Dull			3	6
	N_1	Bright	3	3	3	
	N_2	Dull				9
	N_2	Bright	1	1	7	

N_0=No nitrogenous fertiliser.
N_1=Sulphate of ammonia, 1 cwt. per acre.
N_2=Sulphate of ammonia, 2 cwt. per acre.

fertiliser. Similarly, the phosphate phosphorus was highest in plants from the plots that had received the highest dressing of superphosphate.

With wheat, the nitrate nitrogen was considerably higher in a fallow crop than in a stubble crop. The phosphate content was, however, lower in the fallow than in the stubble crop, probably because of the higher nitrogen supply available to the fallow crop. Oats showed a lower level of nitrate, but a higher level of phosphorus than barley. Peas showed a very high level of phosphate.

Table III illustrates that during dull weather, when photo-synthesis is reduced, the nitrate content of the samples is higher than during bright sunshine.

The above investigation showed that there is a considerable variation in the nitrogen as nitrate, and in the phosphorus as phosphate, in certain localised areas of the plant tissue. The level of these salts is influenced by the fertiliser treatment of the soil. The test for nitrogen has been found to give a reliable indication of the nitrogen status of a number of soils. The opportunity to examine the phosphate test in conjunction with fertiliser trials has not been available at centres other than the Waite Institute.

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Appendix I.

Test for Phosphate in Plant Material.

The reagents are prepared as follows :

Reagent I.—Dissolve 4 grammes of ammonium molybdate in 500 c.c. of distilled water and add, slowly, with constant stirring, a mixture of 63 c.c. of concentrated hydrochloric acid and 437 c.c. of distilled water. As this diluted solution does not keep well, it is advisable to prepare a solution of five times this concentration and dilute as needed.

Reagent II.—Dry powdered stannous chloride or stannous oxalate.

The test is made on material from near the tip of the main stem of cereals or from the leaf petiole of such plants as peas. The sample is gathered from a number of plants representative of the area. A measured volume (5 c.c. loosely packed) of finely chopped stems is placed in a test tube. Ten c.c. of reagent I are added, and the whole vigorously shaken for one minute. A spot of reagent II, about the size of a pin's head, is added and the tube shaken. The colour is observed. Another spot of reagent II is added, and if the colour darkens the new reading is taken.

The colour ranges from dark blue, through green to colourless or yellow, according to the amount of phosphate present, and can be calibrated by comparison with a set of prepared standards.

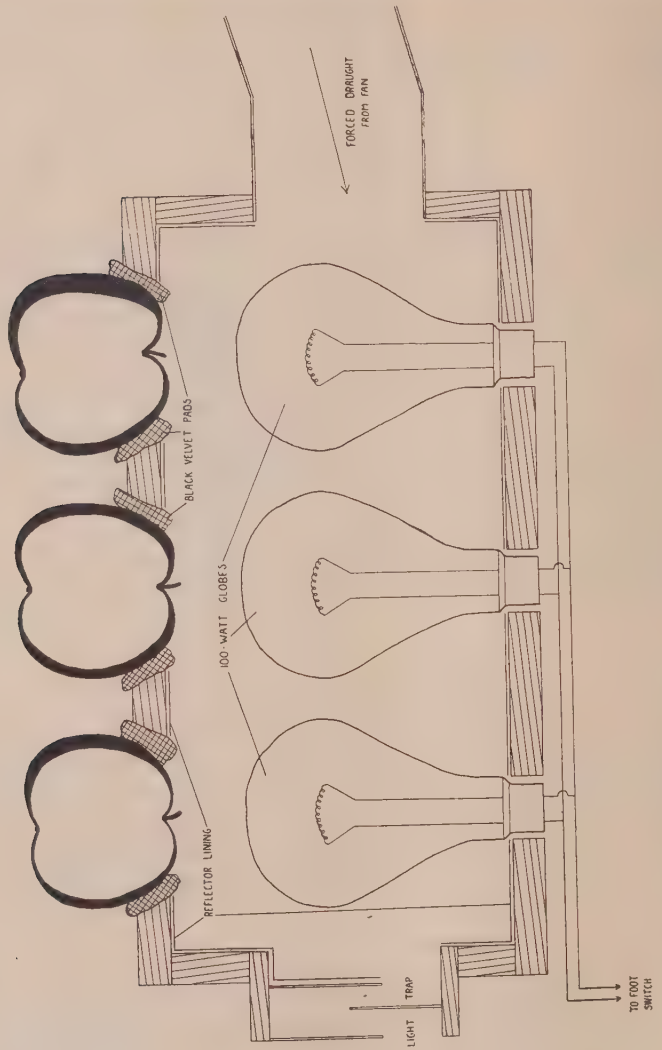
DETECTION OF WATER CORE IN APPLES.

During the 1938 season, the influence of water core on the keeping quality of Rokewood apples was investigated. As is usually the case, there was little surface indication of the presence of water core even though the samples contained many affected fruits. A method was sought whereby normal and affected fruits could be separated without impairing their value for storage tests.

A satisfactory method was provided by observing apples against a strong white light. X-rays and ultra-violet light were tried but proved unsatisfactory.

For the purposes of the test, the apparatus illustrated in the accompanying diagram was constructed. The light from 100-watt electric light globes passed through the apple from the stem end. The presence of water core was revealed by a marked increase in the light transmitted by affected apples when viewed in a dark room or from beneath a hood. In practice it was found that best results could be secured when only the centre hole was used for test purposes, the two end holes being occupied by standards, viz. a water-core-affected and a normal fruit respectively, each determined by cutting.

Only one size of fruit should be examined at the one time.



Badly affected fruit assumes a bright luminous appearance with glowing spots where the water-soaked tissue reaches the surface. Although badly affected fruit can be distinguished with certainty by this method, the detection of slightly affected fruit is not so easy. The method failed, for instance, where there was a slight development of water core in a lens-shaped area in the plane of the light source. Again, in cases where slight patchy development occurred

throughout the flesh, detection was uncertain. Actually it was found that 10 to 15 per cent. of the apples separated as being normal showed this slight form of the disorder.

Despite these deficiencies, the method is useful for the purposes indicated.

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THE OCCURRENCE OF BORON AND MANGANESE DEFICIENCIES IN A SANDY SOIL.

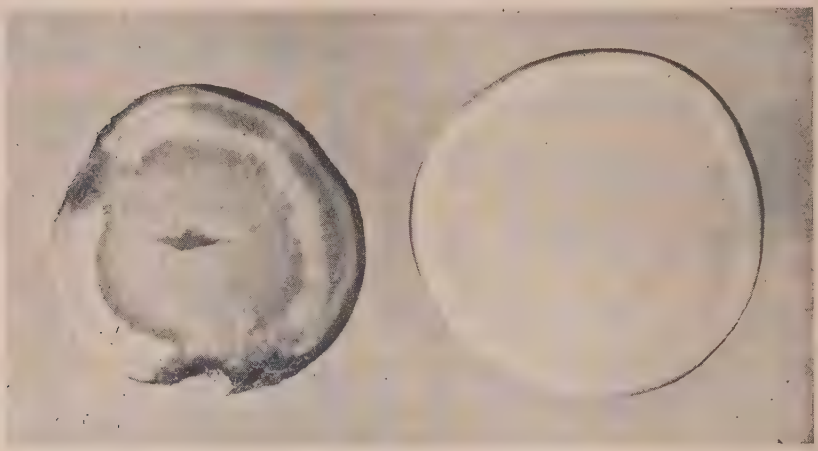
Very few boron-deficient soils have been found in Australia. Carne and Martin[1] in Tasmania, and Savage and Broadfoot[2] in New South Wales have each reported occurrences of internal cork in apples which have been successfully cured by means of borax treatments, but these appear to be the only cases so far reported. In South Australia, Piper[3] made a survey of the boron status of apples grown in the principle apple-growing districts, and as a result of his analyses, came to the conclusion that boron deficiency was not likely to be found in those particular areas.

A soil from McLaren Flat, South Australia, has recently been shown to produce the symptoms of boron deficiency in several plants grown under pot-culture conditions. Both turnips and swedes, when grown in either the surface soil or the subsoil, developed the symptoms of brown heart,[4] whereas quite normal roots were produced when borax at the rate of 10 lb. per acre was added to the pots.

When oats were grown in the same soil, the addition of borax more than doubled the grain yield. Oats have also developed the symptoms of manganese deficiency when grown in the subsoil taken from this area, while the general appearance of all the annual plants grown, suggests that still further deficiencies are by no means unlikely.

McLaren Flat is a district devoted chiefly to the culture of vines and of stone-fruits, and within the last few years a disease of prune trees, possibly due to some mineral deficiency, has appeared. Neither oats nor turnips are normally grown in the district. They were chosen merely as indicator crops which might yield information about the soil.

The prune-tree disease appears to be very similar to little leaf or rosette,[5] as reported overseas, in that growth at the tips of main branches becomes chlorotic, with very reduced leaf size and abnormal form. Growth in this region eventually stops completely, and in the season following the first



Transverse Sections through Turnips grown in McLaren Flat Soil.
Left.—Without borax. *Right.*—With borax at rate of 10 lbs. per acre.

appearance of the trouble, severe die-back develops which proceeds progressively in successive seasons. At the same time growth around the base of the tree becomes abnormally vigorous. Strong lateral growths, apparently quite healthy, develop, from which the main branches may be re-established in two or three seasons, but these in turn become affected.

So far the disease has not responded to any treatment by means of zinc salts, but in view of the results of the pot experiments, a manurial trial is now being made with various minor elements and also with an organic manure.

The soil is a light grey sand, containing a little raw humus, to a depth of 9 to 12 inches, below which a yellow-grey sand continues to a depth of 5 feet. Down to this depth there is only 2 per cent. of clay in the profile. Waterworn gravel appears occasionally in the subsoil, and it seems probable that these sands have been subjected to considerable water-sorting and leaching at some period of their history.

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The Australian Institute of Agricultural Science

MEETINGS OF COUNCIL

August Meeting.

Held in the Animal Health Laboratory, Parkville, Vic., on August 22nd, 1939, at 8 p.m. *Present*: Mr. W. B. Miller (V.) (in chair), Mr. H. J. Geddes (T.), Dr. H. C. Forster (W.A.), Dr. A. E. V. Richardson (S.A.), the Hon. Treasurer, Mr. R. L. Twentyman, the Hon. Secretary, Mr. A. J. Vasey, and the Assistant Hon. Secretary, Mr. R. D. Croll. Apologies were received from Messrs. J. L. Gillespie (N.S.W.), P. S. Lang (Q.) and G. W. Leeper (A.C.T.).

The following were admitted to membership:

To Corporate Membership: W. R. Lang (Vic.), K. F. Plomley (A.C.T.), H. L. Wood (Q.), W. D. Hardy (N.S.W.), M. L. G. Sheldon (N.S.W.), H. R. Richardson (N.S.W.).

To Student Membership: F. Melville (W.A.), T. Robinson (W.A.), F. Grogan (W.A.).

Council approved of the suggestion from the Queensland Branch that that Branch approach the Queensland Government recommending that a Potentialities Survey Unit be formed in the northern State. The Branch considered that the Queensland Survey was beyond its own capabilities. Council urged that the Branch, however, seek representation on any Survey Unit formed, and to keep any activities in close association with the project as at present developed by other branches, with particular reference to (1) availability of information, (2) uniformity of method, and (3) suitability of staff.

The financial statement showed a balance at bank on August 22nd of £149 18s. 4d.

Council approved of an advance of £10 to the Victorian Branch for current expenditure on routine matters.

The meeting concluded at 11.50 p.m.

October Meeting.

Held at the Dept. of Agriculture, Melbourne, on October 5th, 1939, at 5.30 p.m. *Present*: Mr. W. B. Miller (V.) (in chair), Dr. A. E. V. Richardson (S.A.), Messrs. Gillespie (N.S.W.), Leeper (A.C.T.), Lang (Q.) and Geddes (T.), and the Hon. Secretary, Mr. Vasey. Apologies were received from Dr. Forster and Messrs. Twentyman and Croll.

The meeting decided to adopt the suggestion of the Publications Committee in reference to the circulation of suitable numbers of the Journal to administrative authorities, such action to be taken after consideration by Council of the particular issue and after consultation with the various branches as to their views in each case.

The following were admitted to membership:

To Corporate Membership: D. I. Shew (Vic.), F. J. Gay (A.C.T.), R. C. Hutchinson (A.C.T.), J. Stewart (N.S.W.), E. J. Smiles (N.S.W.), A. G. Turton (W.A.), J. T. Gemmell (Tas.).

To Student Membership: R. W. Kerr (Tas.).

The financial statement showed a balance at bank on October 2nd of £116 12s. 10d.

MEETINGS OF BRANCHES

New South Wales Branch.

The twenty-sixth meeting of the Branch was held on 8th September. The death of Mr. S. Garthside, a Sydney graduate in agriculture, under tragic but heroic circumstances was referred to by Professor Watt, who moved a motion of sympathy with his relatives. The meeting observed a period of silence.

The progress of the Agricultural Potentialities Survey was communicated by Professor Watt, and a new Branch project on Pasture Growth Curves was discussed.

Mr. S. Cook, Deputy Headmaster, Hurlstone Agricultural High School, Glenfield, gave an address entitled "Biology in Relation to Agriculture". The teaching of biology, particularly at rural high schools, was traced through the several different syllabuses of the past eighteen years. Each syllabus received its share of criticism, the main grounds being complexity of subject matter, unsuitable arrangement of the branches of the subject, and inadequate teaching time. The primary need in teaching this subject was to give to the student a biological outlook of both scientific and cultural value. This objective would be sought in the development of the subject in syllabus, as adjusted to the practical difficulties of teaching. The lecturer also referred to the value of visual education and of agricultural publications in rural schools. Agricultural teaching could, with advantage, make closer contact with the workers of the Department of Agriculture. A general discussion followed.

At the November meeting the main business was an address by Professor T. Hytten on Economics, Agriculture, and the War, a summary of which appears under "Current Notes and News". The meeting observed a two minutes' silence for the recent death of Mr. W. B. Gurney. Mr. F. T. Bowman was elected sub-editor of the Journal in New South Wales, in place of Mr. L. S. Cayzer, whose resignation (submitted in consequence of his change of work) was received.

Victorian Branch.

New members admitted this year total 14, and, allowing for inward and outward transfers, the present membership of the Branch is 109 (corporate) and 3 (student).

The Branch has been invited to co-operate with the Victorian Institute of Surveyors and the Institution of Engineers in a joint campaign in connection with the problem of soil erosion in Victoria.

A meeting held on October 30th was addressed by Dr. Isaac Steinberg, Secretary of the Freeland League, London, on "The Proposals for Jewish Colonisation in the Kimberleys". (Attendance: 50). After outlining the reasons why Australia should assist in solving the refugee problem, Dr. Steinberg said the four principles upon which this and similar schemes were established were: (1) not infiltration, but colonisation; (2) no competition with established industries; (3) no political aspirations—there would be no attempt to set up a Jewish state or political unit; and (4) no charity—the new settlement would be a business proposition. He said he had obtained the support of the W.A. Government, leading citizens and trade unions. He intended eventually to approach the Federal Government. The area to be developed lay due south of Wyndham and was 1½ million acres in extent. The rainfall was 24 to 26 inches. The Ord River could be dammed for irrigation purposes. Although the climate was trying for part of the year, its unpleasantness could be mitigated by rational diet and housing; community, rather than individual, settlement; and regulation of hours of labour to avoid outdoor work during the middle of the day. The

scheme envisaged a modern scientifically planned colonisation. Before any attempt was made at actual settlement the possibilities would be thoroughly investigated by the best scientific authorities obtainable. Economic as well as cultural potentialities would be surveyed. Australia would not be called upon to provide any finance. Development would be gradual. At the outset 500 to 600 young, selected, trained Jews and Jewesses would be sent out. The number of settlers would be increased in accordance with the capacity of the country to absorb them.

Members of the Branch attended the following meetings held by the Melbourne University Agricultural Society:

August 25th: Address by Mr. W. J. B. McDonald, B.Agr.Sc., Senior Plant Investigation Officer, Department of Agriculture (Vic.), on "Australian Tobacco—Its Struggle for its Place in the Australian Pipe". (Atendance: 32.)

September 15th—Undergraduates' Night: Two undergraduates, Messrs. J. Roberts and R. W. Spicer, gave papers on "The Northern Territory" and "The Rural Home" respectively. (Attendance: 47.)

October 6th: Mr. R. W. Prunster, B.Agr.Sc., Division of Plant Industry, C.S.I.R., spoke on "Control of Weeds in Irrigation Channel Systems, with Special Reference to the Control of Cumbungi (*Typha* sp.)", and told of the remarkable success obtained in the latter case by repeated cutting of the weed back to sub-surface level. (Attendance: 45.)

South Australian Branch.

A joint meeting with the local branches of the Australian Chemical Institute and the Australian Institute of Forestry was held on August 14th and addressed by Sir David Rivett. The audience was augmented by the presence of members of the Winter School in Soil Science and other visitors.

Sir David, in his address on "Fisheries Investigations Around Australian Coasts", first dealt with their history up to the year 1936, when the Council for Scientific and Industrial Research assumed responsibility for their development. After conveying an impression of the wide basis for such investigations in a newly-settled country bound with 12,000 miles of coastline, the speaker went on to describe the lines along which work was being done. This had required the equipment of a special vessel, the "Warreen", and suitable quarters on land. Such facilities had been established at Port Hacking, New South Wales.

With the aid of a projector, Sir David then went on to illustrate several phases of the work. The great supplementary value of aerial survey in locating large shoals of pelagic fish was clearly shown. The species of fish of likely value—tuna and salmon—were described and illustrated, and the progress that is being made in their commercial utilization was indicated.

Queensland Branch.

The meeting on 25th August took the form of an excursion to the Queensland Agricultural College and High School at Lawes. Business comprised addresses from officers of the College and from officers of the C.S.I.R. stationed there. Professor J. K. Murray (Principal) welcomed the visitors and discussed the functions of an agricultural college. He indicated the association of the College with research work by the C.S.I.R., in addition to maize-breeding at the College. Mr. N. Britton outlined the animal husbandry work. Mr. C. S. Webster described the agricultural features;

the area is 1,760 acres, of which about 600 acres are cultivated. Mr. C. S. Christian detailed the work of the Genetics Section of the C.S.I.R. at the College, the main concern being the production of improved strains of pasture plants. Mr. A. Schindler stated that the plant breeding section of the College aimed at the production of hybrid maize throughout southern Queensland, and he outlined the methods adopted. Mr. T. B. Paltridge gave an account of plant introduction work. The centre of introduction is at Canberra; Lawes is the centre for south-eastern Queensland and north-eastern New South Wales, and Rockhampton for the central coast. Mr. W. M. Willoughby outlined the weeds investigations of the C.S.I.R. in Queensland. Next day the visitors were conducted over the College and current work was demonstrated.

On 29th September a symposium on soil nitrogen was held. Mr. A. F. Bell described the testing and use of nitrogen-fixing bacteria, illustrating by means of photographs. In tests of relative efficiency of several strains of Rhizobium, sterilised silver sand plus kaolin was used as a medium; painted pots were superior to porous, owing to the lower evaporation rate. Mr. W. G. Wells dealt with nitrogen in cotton soils. Excess nitrogen during the growing period has an adverse effect on cotton yields. In land cropped with cotton for some years the rate of nitrification is much higher than in newly-broken grassland. The remedy is to grow cotton for only three years and revert to grass for a similar period to reduce the nitrate content. Cotton can then be grown satisfactorily for a further three years. Mr. C. R. von Stieglitz discussed nitrogen in sugarcane soils and showed that continuous cane cropping causes marked depletion. The decomposition rates of green manures, trash and cane by-products were discussed and the necessity of augmenting the available nitrogen when utilising cane trash was stressed. Mr. C. S. Christian spoke on the maintenance of the nitrate content of pasture soils. The two important methods of returning nitrogen to the soils are nitrogen fixation by the use of legumes and top-dressing.

Western Australian and Tasmanian Branches,

The October meeting of the W.A. Branch was held on 6th October, being arranged as usual during Royal Show week to afford country members an opportunity of attending. The meeting was addressed by Mr. R. B. Williamson, W.A. Producers' representative on the Australian Meat Board, on the general activities and functions of that Board, and the special steps that were likely to be taken to meet the exigencies of war-time conditions.

A meeting of the Tasmanian Branch was held at Hobart on the 22nd September, at which Mr. P. H. Thomas gave a paper on the comparison of pre-war conditions in relation to fruit growing in 1914 and those existing at the present time. The paper was of general interest and considerable discussion resulted. The Minister for Agriculture (Hon. T. D'Alton) was present by invitation.

Current Notes and News

Economics, Agriculture and War.

At the November meeting of the N.S.W. Branch of the Institute, Professor T. Hytten, Economic Adviser to the Bank of New South Wales, gave an address with the above-mentioned title, in which he broadly reviewed the effect of war on economics and agriculture during the past thirty years.

Before 1914 a free economy prevailed, without tariffs or economic protection in Europe, for agricultural products except sugar. With free markets the world over, price levels were not dominated by any particular group and thus they served as an effective barometer or guide to the expansion of production. In the course of the last war the previous free economy changed to a controlled economy. Uncertainty of supply and shipping difficulties caused a rise in world prices; the British Government acquired essential products at guaranteed prices. In 1914 drought in Australia reduced stock to levels which were not reached again till the end of the war; the drought drastically reduced wheat and dairy products also. But in response to the price situation towards the end of the war, agricultural production greatly increased and presented a problem of accumulated stocks. The high prices that ruled shortly after the war induced the Government to throw open land for repatriation schemes, which later greatly increased production, and led ultimately to the 1929-30 slump.

The after-war attempt to return to free economy started with great accumulations of stocks and with price speculation which was ultimately borne by the producers. Bawra liquidated the wool stocks, but wheat prices suffered; butter prices also fell until the establishment of the Paterson Plan and later the Equilisation Scheme. In post-war Europe, self-sufficiency has become a shibboleth; international trade is greatly curtailed by exchange restrictions and extraordinary protection; substitutes have taken the place of some imported agricultural products.

At present, then, world economy is partially controlled and the change to the completely controlled economy of war time can be made more readily than 25 years ago. In the change, it should be observed that the prices of acquired products should not unduly encourage production and lead to a later slump; they should also be sufficient to pay for good quality products, efficiently produced, yet not high enough to encourage uneconomic production. The government acquisition of stocks should be such as shall not cause us to lose markets for our products.

Agricultural Sciences Club, S.A.

At a meeting held on 22nd August three papers were read. Professor J. A. Prescott, in discussing evaporimeters, said that a more rigid standardisation of their size was desirable. Diagrams illustrating the dependence of evaporation on saturation deficit, wind velocity, air turbulence and the intensity of solar radiation were shown. A good correlation between rate of evaporation on the one hand and saturation deficit combined with the intensity of solar radiation on the other, was revealed.

Mr. H. G. Andrewartha dealt with data relating to the important development of the Australian locust (*Chortoicetes terminifera*) in the semi-arid pastoral areas of South Australia during the spring and summer of 1934. The absence of a well-developed seaward drainage system, the lack of reliable winter rains and the variability of the rainfall in the semi-arid areas were important factors in the ecology of this insect.

The approach to the problem of erosion in the pastoral areas was discussed by Mr. K. Woodroffe. Most of the approach made so far followed ecological lines, but some attention had been given to studying the properties of the soils in these areas.

At the September meeting, Mr. C. A. Neal Smith read a paper on seed germination studies. The seeds dealt with were mainly of species derived from the more arid areas. The effects of scarification or treatment with concentrated sulphuric acid on germination percentages were also described.

An exhibit demonstrating some of the optical properties of tobacco mosaic virus was shown by Mr. R. J. Best.

The October meeting, held in the afternoon, was opened with a paper by Mr. G. D. Hubble on the soils and drainage in the Mildura Irrigation district. Analyses of these soils have revealed that they possess three interesting features, *viz.*: (*a*) a high silt content, (*b*) a high content of phosphoric acid, and (*c*) chloride constitutes a small proportion of the soluble salt. Sodium sulphate, however, is relatively important in this fraction.

"Dairy Science Abstracts."

All engaged in dairy science will welcome the advent of "Dairy Science Abstracts", a new journal published by the recently-founded Imperial Bureau of Dairy Science, Reading, England. While the "List of References from Current Literature" prepared by the library staff of the National Institute for Research in Dairying has done much in the past to meet the demand for some means of surveying dairy literature, the need for a comprehensive abstract journal has been long felt. The provision of such a journal was recognized as one of the principal functions of the Bureau of Dairy Science, and its appearance marks an important step in the development of that organization.

The first number of "Dairy Science Abstracts" was published in May, 1939, and it will be issued quarterly. It is divided into sections under the headings of Husbandry, Technology, Control and Standards, Economics, Physiology, Bacteriology and Mycology, and Miscellaneous. The sections are further subdivided and an author index appears in each issue. Author and subject indexes will be provided for each annual volume. Titles of articles are included with full details of place of origial publication, and in most instances an abstract of the subject matter is given. Authors are invited to submit reprints of articles which will be catalogued and made available for loan. The subscription is 25/– per volume of four numbers, post free, which is payable in advance. A discount of 5/– is provided for British subjects who send their subscriptions direct to the Bureau.

Recent Bulletins of Imperial Bureaux.

"*Fruit Juices and Related Products*", by V. L. S. Charley and T. H. Harrison, is the title of Technical Communication No. 11 recently issued by the Imperial Bureau of Horticulture and Plantation Crops. Mr. Charley gives a detailed account of the manufacture of apple juice, and a brief statement on other fruit products such as grape, citrus and soft fruit juices, cider, fruit wines, etc. Dr. Harrison's contribution deals with the economic and nutritional aspects. The Bulletin runs to 104 pages, and contains 49 figures and a bibliography of 118 citations. The price is 5/–.

"*Soil-borne Fungi and the Control of Root Disease*", by S. D. Garrett, is the title of Technical Communication No. 38 issued by the Imperial Bureau of Soil Science. The publication will be welcomed by root-rot investigators, dealing as it does with the rôle of fungi in the soil, plant sanitation, elimination of infectious material from the soil, adjustment of soil conditions to check activity of parasites, and the augmentation of host resistance. The Bulletin runs to 54 pages and contains an extensive bibliography. It is priced at 2/6.

Book Reviews

LAND UTILISATION IN AUSTRALIA, by S. M. Wadham and G. L. Wood.

(*Pp. xix+360, with 52 diagrams and 48 half-tone illustrations. Melbourne University Press, 1939. Price, £1 1s.*)

The eagerly awaited book by Professor S. M. Wadham and Dr. G. L. Wood is the third of a series sponsored by the International Institute of Pacific Relations. The first of these, " Agricultural Organisation in New Zealand ", appeared in 1936 under the editorship of Professor H. Belshaw; the second, " Land Utilisation in China ", appeared in 1937 as a result of investigations directed by Professor J. L. Buck at the University of Nanking. Each book has its own special characteristics, the main contrast being due to the relative stability of agricultural occupation in China as against the sense of flux associated with development in new countries like Australia and New Zealand.

The authors regard the system of land utilisation which has so far emerged in Australia as a response to the three controls of seasons, soils and sales, these being considered to be more fundamental to successful settlement than the trinity of men, money and markets postulated during the period of intensive development characteristic of the period round 1926. With these controls in mind, the book takes its shape, and after a historical introduction, the natural factors controlling the use of land are dealt with. Chapter II is devoted to a consideration of climate, vegetation and soils, affording a useful summary of published work in this direction up to the year 1937. An interesting feature in this section is the discussion of the cost of clearing.

The remainder of the book deals in turn with the industries associated with the production of wool, wheat, dairy products, meat, sugar, fruit and other crops. The emphasis placed on the production and marketing side of each particular product of necessity results in the covering of some of the same areas a number of times, as when wool, wheat and mutton are produced on the same farms, but on the whole a sense of unity is achieved and due cross reference is made to the overlapping of industries in the same major areas. Two chapters are devoted to irrigation and forestry respectively.

The last two chapters, dealing with land utilisation and settlement and the effect of world economic trends on land use in Australia, afford an excellent summary of the present position and are of quite general interest.

The agricultural scientist will find the book indispensable as a reference book on historical and statistical matters. One would have liked to have seen some discussion on systems of farming as opposed to the production of individual crops, but possibly it is too early in the history of Australian agriculture to expect this.

J. A. Prescott.

THE GENETICS OF GARDEN PLANTS, by M. B. Crane and W. J. C. Lawrence.

(*Second edition, pp. xxi+287, with 62 illustrations and 43 tables. London: Macmillan & Co., 1938. Price, 12/6.*)

This book deals with the recent results of genetical and cytological work in horticultural crops. The first three chapters are devoted to a brief and clear exposition of the essential principles of the genetics and cytology of diploid and polyploid plants, both of which are represented in horticultural crops. The remaining eight chapters give a very readable

account of the genetical behaviour of some flower, vegetable and fruit plants and the genetical aspects of incompatibility, sterility, and the origin of new and improved forms.

The known breeding responses of these plants are assembled from diverse sources of information, but mainly from the work of the authors and their colleagues at the John Innes Horticultural Institution, England. Such an account reveals the striking advances that have been made in genetical and cytological knowledge, particularly of polypoid fruit plants, and to which this Institution has largely contributed.

Although essentially a technical book, a study of the introductory chapters and use of the glossary should make the contents available to a variety of horticultural workers. To seedsmen and nurserymen, this work presents a detailed knowledge of variation and heredity as a guide to the maintenance of purity of their stocks. For horticulturists and horticultural advisory workers, the chapters on sterility and incompatibility, in particular, will have a wide practical application. To more specialized workers, the book presents a valuable summary of scattered papers and a basis for work with individual crops.

The " Genetics of Garden Plants ", first published in 1934, now appears in a second edition. The first three chapters on the principles of genetics have been expanded by additional sections. A new chapter on the chemical and genetical basis of flower colour has been added. Other chapters have been emended, especially those on incompatibility and the origin of new and improved forms. There are three useful appendices, namely a list of the chromosome numbers of cultivated plants, a glossary and a bibliography. The book is well indexed.

F. T. Bowman.

SOCIAL PROBLEMS IN AGRICULTURE.

International Labour Office. Studies and Reports, Series K (Agriculture), No. 14, pp. iv+162. Geneva, 1938. Price, 4/-.)

This report deals with the findings of a meeting of the permanent agricultural committee of the International Labour Office held in February, 1938. Officers of the I.L.O. prepared a series of general reports prior to the conference, and these reports cover 87 pages. A summary of the debates follows, and then the report of the committee itself. The position regarding hours of work, holidays with pay, protection of child labour, and the form and extent of wage regulation is surveyed with respect to legislation, custom and agreement in various countries in the world. In view of the fact that (taking into consideration the 550 million people engaged in agriculture) wage earners in agriculture are in a minority of 15 per cent., the committee felt that the question of the standard of living of the agricultural population was of considerable importance, and that the ability of the peasant and small farmer to pay satisfactory wages was governed entirely by the economic state of affairs in the industry. Suggestions were made for further investigations in this field. Mr. F. L. Macdougall, the representative of Australia on the committee, was primarily responsible for influencing the committee in this direction.

J. A. Prescott.

LES SOLS DE L'AFRIQE CENTRALE SPECIALEMENT DU CONGO BELGE. Tome 1: Le Bas-Congo, By J. Baeyens.

(*Pp.* 375, *with* 40 *illustrations,* 30 *figures and* 9 *maps. Gembloux, Belgium: Imprimerie J. Duculot,* 1938. *Price,* 150 *fr.*)

This very thorough and comprehensive work has been written by Professor Baeyens, in collaboration with several colleagues of the University of Louvain, to summarise the results of soil surveys undertaken by him since 1934 in the Belgian Congo.

The first part of the book deals with field descriptions of the soils, and discusses their physical and chemical properties and their origin. Extensive laboratory examinations were undertaken, partly in Africa and partly in Belgium, the use of rapid methods enabling over 10,000 analyses to be carried out. It was found that much of this chemical and physical data could be correlated with soil type and with crop yields, thus permitting a valuation of virgin land from the results of profile examinations in the field and in the laboratory. This practical use of the soil survey constitutes most of the second half of the book. The soil characters, both physical and chemical, which are most suited to the various crops grown, are defined, passing from those which are most exacting in their requirements, such as cocoa, sugarcane and coffee, to those like rubber and the oil palm, which can thrive on poorer soils.

The soils of the Belgian Congo are highly laterised and, like many tropical soils, are poorly supplied with reserves of plant foods, if judged by the standards of temperate regions. Their fertility is rather to be ascribed to their good texture and to climatic conditions which permit a very rapid turnover of such plant foods as are available.

Though much contained in this book is chiefly of local value, or of value to those interested in tropical agriculture, yet most of the first section will be of great interest to the student of pedology. Taken as a whole, the book provides an excellent example of the modern scientific approach to the general problem of soil valuation and of land utilization. It is very fully illustrated and is concluded by an extensive and classified bibliography of 37 pages.

ALLAN WALKLEY.

MICROBES BY THE MILLION, by Hugh Nicol, M.Sc., Ph.D., F.I.C.

(*Pp.* 242, *with* 16 *figures and* 8 *plates. The Penguin Book Co., Harmondsworth, Middlesex. Price,* 9*d.*)

Written by Dr. Nicol of the Rothamsted Experimental Station, " Microbes by the Million " is one of the well known series of Penguin publications. The author has endeavoured to treat the subject of soil microbiology in a manner which can be understood and appreciated by the ordinary reading public. In general the fundamental association of biological activity in the soil with fertility and productivity has been emphasized and a number of practical experiments, capable of being performed with ordinary household materials and equipment are described. Written with an eye to popular appeal, " Microbes by the Million " can in no sense be described as a text-book. It is capable, however, of presenting some refreshing angles and sidelights on the subject of soil bacteriology to even the most serious student.

E. G. PONT.

Obituary

W. B. GURNEY

On September 21st, 1939, William Butler Gurney, Chief Entomologist, Department of Agriculture, N.S.W., passed away after a short illness. The late Mr. Gurney was born at Sydney on May 2nd, 1882. He entered the Department of Agriculture as assistant to the late Mr. W. W. Froggatt in 1900, and was appointed Chief Entomologist in 1923.

Though he published papers on a wide range of insect pests, he was specially interested in the plague grasshopper, the fruit fly, and in the introduction of parasites. Perhaps the most notable achievement of his official career was the introduction into New South Wales in 1924 of *Aphelinus mali,* the parasite of the woolly aphid, which has been an outstanding success.

In 1928-29, Mr. Gurney toured the United States, Europe and England, enquiring into recent developments in pest control, and was an N.S.W. delegate to the Fourth International Congress of Entomologists held at Cornell University (U.S.A.) in 1928. In 1934-35, at the request of the Fruitgrowers' Federation of N.S.W., he visited India and East Africa to search for parasites of fruit flies and white wax scale. As a result of this trip, a number of species of parasites of both these pests have been forwarded to Sydney and several have been developed and liberated in the field.

Mr. Gurney was a fellow of the Royal Entomological Society of London and a member of several scientific societies, including the Linnean Society of N.S.W., the Royal Zoological Society of N.S.W., the Australian and New Zealand Association for the Advancement of Science and the Australian Institute of Agricultural Science. He was a past President of the Naturalists' Society of N.S.W.

A man of simple tastes, he was keenly interested in music, art and literature. He possessed a marked originality of mind, and brought a refreshing enthusiasm to the many problems which arose in his official work. Essentially kindly, sympathetic and understanding, his many friends regret the passing of a generous and genial character.

Personal Notes

Professor S. M. Wadham, who is abroad on sabbatical leave, spent several weeks in Europe during the summer visiting Denmark, Germany and Holland, and returning to England in August. His headquarters are at Cambridge, pending his return to Australia early in the new year.

Dr. W. L. Waterhouse has been elected representative of the Faculties of Agriculture and Veterinary Science on the Standing Committee of Convocation, Sydney University.

Mr. J. M. Ward, Superintendent of Horticulture, Victoria, who was recently abroad investigating the condition on arrival and marketing of Victorian fruit on the British and Continental markets, returned to Melbourne in September, via Canada and U.S.A. Others who have recently returned from overseas include Dr. E. T. Edwards and Mr. G. de V. Davis (N.S.W.), Mr. K. L. Hills (A.C.T.) and Professor J. Davidson and Mr. J. K. Taylor (S.A.).

Mr. L. S. Cayzer has resigned from the N.S.W. Department of Agriculture to take up a position with the firm of N. B. Love, Ltd., flour millers. Since 1934, when he spent a period abroad as Farrer Scholar, Mr. Cayzer has specialised in cereal chemistry.

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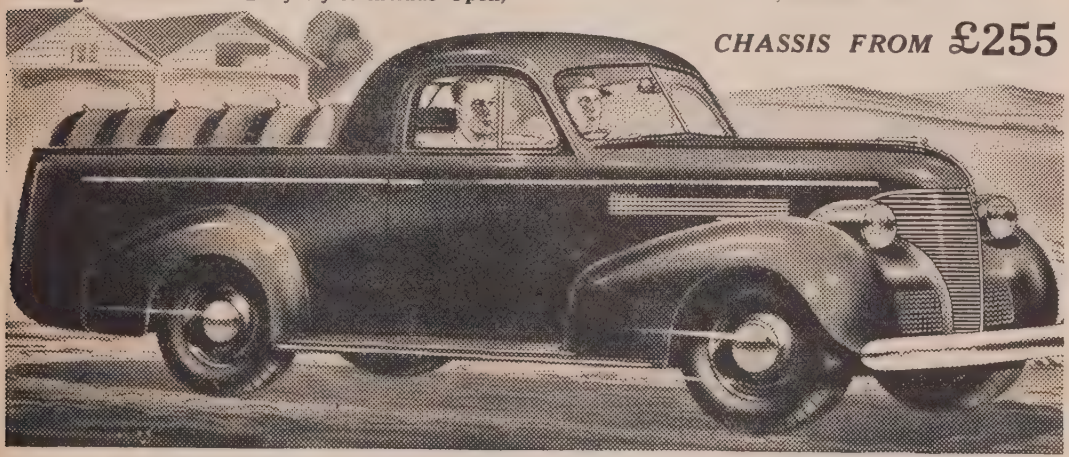

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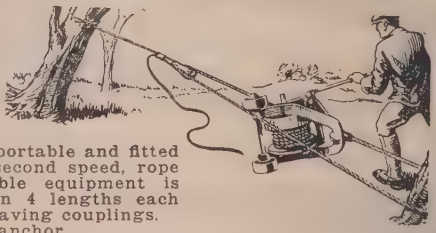

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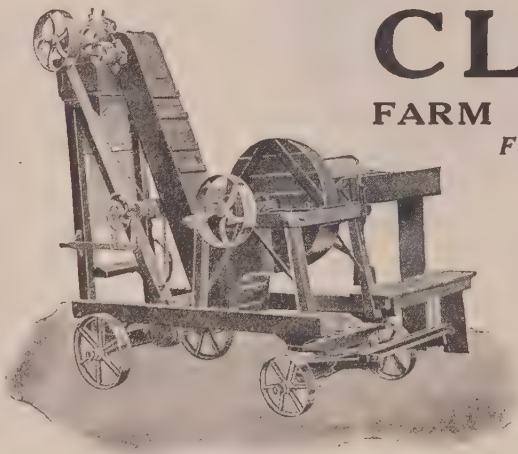

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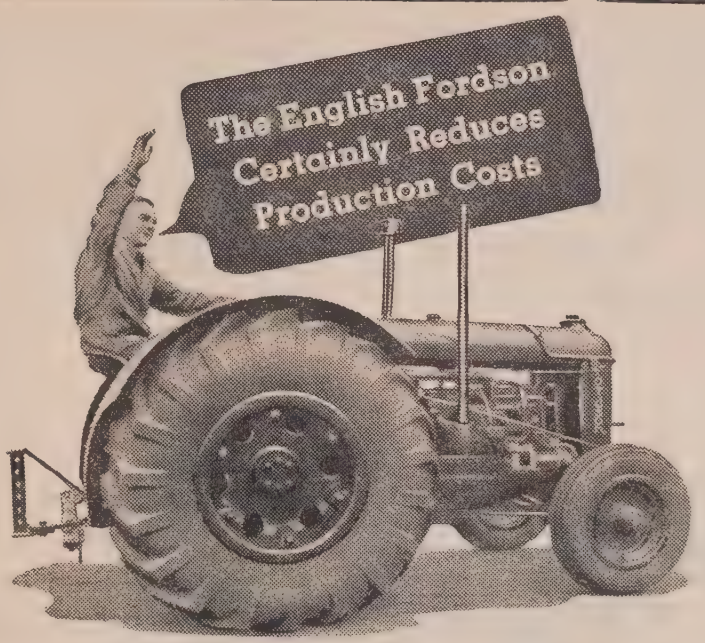

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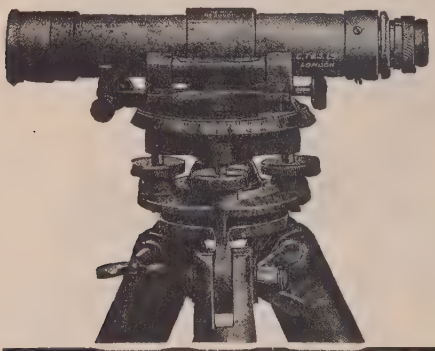

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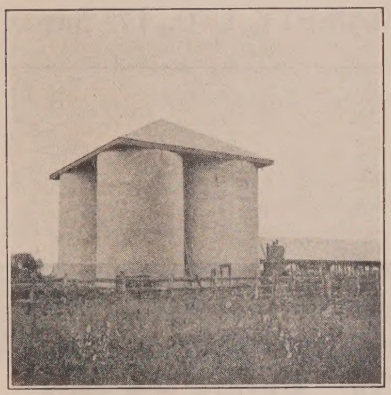

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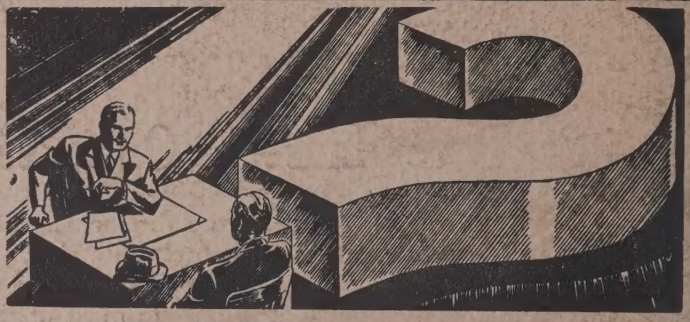

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